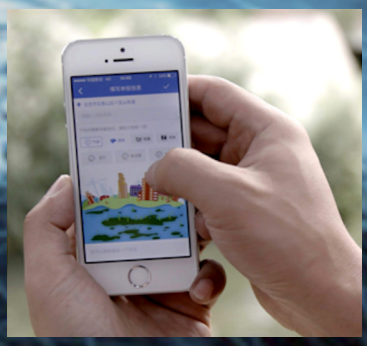
Summative Evaluation:
Broadcast & Digital Media Report

The Crowd & The Cloud



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About Rockman et al:

Rockman et al is an innovative research, evaluation, and consulting company that specializes in examining critical issues in formal and informal education. The Rockman team includes evaluators with diverse backgrounds and skill sets who help clients answer critical questions in clear, direct, and honest ways. Rockman et al has served as the lead evaluator for numerous projects funded by the National Science Foundation as well as several other public and private funding agencies. Learn more at www.rockman.com.

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Executive Summary

The Crowd & The Cloud, a three-year project, developed by Passport To Knowledge and funded by the National Science Foundation, uses multimedia to engage different audiences around citizen science and crowdsourcing. The project team created four episodes of a broadcast television series, which appeared on PBS stations and via PBS.org, an interactive website, and a robust social media presence in an attempt to reach three target audiences: the general public, scientists, and citizen scientists. This report and the findings below focus on the use and impact of The Crowd & The Cloud's broadcast episodes on viewers, and the impact of The Crowd & The Cloud's website and social media on participants.

Rockman et al (REA), an independent educational research and evaluation firm, conducted an external evaluation of The Crowd & The Cloud's broadcast series via online surveys and in-person focus groups, and The Crowd & The Cloud's website and social media via online analytics, surveys, and focus groups. In addition, telephone interviews were conducted with citizen science leaders whose projects were featured in the series or on the website, members of the general public who signed up to participate in a citizen science project after viewing an episode of the series, and with The Crowd & The Cloud project's advisors. The evaluation of the project addressed the following questions:

- How, where, when, why and with whom can media generate deeper involvement in citizen science?
  - Were specific media elements more effective than others in having an impact on participants?
  - What is the cumulative impact of The Crowd & The Cloud's broadcast and digital media?
- How do viewers engage with The Crowd & The Cloud's broadcast series, website, and social media?
- What are the impacts of The Crowd & The Cloud's broadcast series, website, and social media on viewers' attitudes, behaviors, awareness of, and skills around citizen science?
- How do the impacts of the broadcast series differ by audience type (i.e., general public, scientists, and citizen scientists?

Key Findings

Viewing The Crowd & The Cloud Series

- Most survey respondents (N=331) chose to watch an episode of the series because they like science documentaries (61%) and/or the topic of citizen science (56%)
- Survey respondents tended to watch episodes live on a local PBS station
- Those who watched via WORLD Channel were likely to view the live roundtable discussion that occurred afterwards (80%, N=75)
  - Of these, most felt that the roundtable discussion had enhanced their viewing experience (95%, N=60)
- Respondents who viewed episodes via The Crowd & The Cloud website tended not to notice the Twitter feed available on the side of the screen, likely because it was not visible in full screen mode
  - Of those who saw the Twitter feed, the majority felt that it had enhanced their viewing experience (66%, N=41)

Impacts of the Broadcast Series - Across All Audiences

- After watching an episode, viewers:
  - expressed greater familiarity with and understanding of citizen science and crowdsourcing
  - had increased confidence in their ability to do citizen science
  - were more likely to engage in certain citizen science activities, such as gathering information about citizen science, posting about citizen science on social media, and investigating citizen science projects in their local area
  - had more positive beliefs about who could collect data, the validity of that data, and how data can be utilized

"Individuals can make a difference. Maybe there's something that I can help with."

- Program Viewer

Impacts of the Broadcast Series on the General Public

- Compared to those who had not watched the series, members of the general public who viewed an episode:
  - expressed greater familiarity with and understanding of citizen science
  - had increased confidence in their ability to do citizen science
  - were more likely to engage in citizen science-related activities
  - had more positive beliefs about who could collect data and the validity of that data
    - However, they also felt that collecting scientific data can be challenging, and that analyzing data should be left to professional scientists

Impacts of the Broadcast Series on Professional Scientists

- Scientists who took the survey were more familiar with citizen science and crowdsourcing than the general public. However, in focus groups, only slightly more than half (54%) were familiar with the terms.
  - Scientists who viewed an episode still gained a significantly greater understanding of specific aspects of citizen science than those who had not watched the series
- Scientists had mixed reactions to the participation of the general public in scientific research
  - Scientists who viewed an episode were significantly more likely to view citizens as potential data collectors than those who had not viewed the series
  - However, scientists who viewed an episode were also significantly more likely to believe that only professional scientists should analyze data
  - Furthermore, some scientists felt that data collected by citizens can be just as valid as data collected by scientists, while others questioned the reliability of citizen-collected data
- Viewing the series did not really impact scientists' participation in citizen science
  - The exception was that scientists who watched an episode of the series were significantly more likely to post about citizen science on social media than those who had not watched the series, suggesting a willingness to share information about the citizen science movement with others

- Scientists who viewed an episode liked seeing the wide range of projects represented in the series

Impacts of the Broadcast Series on Citizen Science Participants

- Compared with those who did not watch the series, citizen science participants who viewed an episode displayed a significantly greater understanding of the relationship between crowdsourcing and citizen science
  - They also gained a significantly greater understanding of how citizen science findings are used by others
- Citizen science participants who viewed an episode appreciated the focus on different technologies that can be employed to aid citizen science efforts, and the wide range of projects represented in the series

> **"Science is not only something you can learn about, but something you can do."**
>
> **- Website User**

- Citizen science participants who viewed the series liked that the episodes showcased citizen science initiatives that were realistic, relevant, and fun
- Citizen science participants tended to sign up for projects that aligned with their general interests

The Crowd & The Cloud Website Use

- Increases in website traffic were associated with the four major episode airdates in April 2017
  - The main way that users found out about the website was from watching an episode of the series on television
- Users visited the website to watch or rewatch episodes, to find out more information about the series or citizen science, and/or to get involved in a project

> **"There is no way I can see myself joining a project without the website."**
>
> **- Website User**

- Webpages, such as the "Citizen Science Calendar" or "Join a Project" were popular, suggesting that users were interested in learning how to get more involved in citizen science initiatives

Impacts of The Crowd & The Cloud Website on Users

- Website users had more familiarity with and understanding of citizen science concepts than those who had not visited the website
- Website users exhibited more positive beliefs about citizen science than those who had not visited the website
  - Compared to non-users, website users were significantly more likely to agree that:
    - Anyone can be a citizen scientist
    - Data collected by citizens can be as valid as data collected by professional scientists
    - Data collected by citizens can be published in scientific journals
- Website users expressed greater confidence in their ability to engage in citizen science-related activities than those who had not visited the website
- Website users were significantly more likely to engage in citizen science-related activities than those who had not visited the website
  - In particular, they were more likely to:
    - Keep up with recent citizen science news and research
    - Visit citizen science-related websites
    - Post or share citizen science topics on social media
    - Investigate citizen science projects in their geographic area
    - Indicate they might participate in a citizen science project in the future
  - Following their visit to The Crowd & The Cloud website, many users (4,487) went to SciStarter, an online searchable database of citizen science projects, with some (282) signing up for a project, indicating their desire to engage more deeply with citizen science

The Crowd & The Cloud Social Media Use

- Social media amplified and extended the life of The Crowd & The Cloud
  - Social media traffic was the third largest source of traffic to the website, after direct referrals and organic searches

> **"[Social media] was a way of getting many different types of viewers connected to the material. It was a way of putting small chunks of materials out to whet their appetites, and to excite and bring attention to the field, and to mobilize people around participation."**
>
> **- Project Advisor**

- Twitter was the most successful social media platform for attracting new followers
  - From March through June 2017, there were 1,300 new followers of The Crowd & The Cloud's Twitter account
- Facebook was the most successful social media platform for retaining and more deeply engaging new followers
  - Facebook videos were popular, particularly those that mentioned Alzheimer's research, cross-promoted an event, or included live roundtable discussions with individuals from citizen science projects featured on the broadcast series
- The most engaging posts across social media platforms tended to have the following characteristics:
  - Included colorful images or videos with little to no text
  - Mentioned an individual or group affiliated with a citizen science project featured on an episode in the series or the website
  - Had slightly longer character counts and used more hashtags
  - Posted in April, in conjunction with the television broadcast air dates

- The most popular Instagram posts were colorful, featured high quality photography, and/or featured animals in scenes that are difficult to capture

Cumulative Impact of The Crowd & The Cloud's Broadcast & Digital Media - Across All Audiences

> **"One of the points was that scientists are no longer alone. With smartphones and cameras, it's becoming easier to get an ordinary citizen involved."**
>
> **- Program Viewer**

- Compared to those who only viewed an episode, those who both watched an episode of the series and used the website were significantly more likely to:
  - Be familiar with the terms, "citizen science" and "crowdsourcing"
  - Understand how citizen science data is collected and how it can be used to address environmental problems
  - Feel confident that they could contribute to initiatives that would help their community, interact and work with a professional scientist, contribute to meaningful scientific research, and analyze and interpret data
  - Believe that anyone can be a citizen scientist, that professional scientists can use data collected by citizens, and that it is difficult to learn how to collect scientific data
  - Visit citizen science websites, post or share about citizen science topics on social media, and discuss citizen science with friends and family
  - Investigate citizen science projects in their local area and indicate that they might participate in citizen science projects in the future
- Compared to those who only used the website, those who both watched an episode of the series and used the website were significantly more likely to:
  - Be familiar with the term, "citizen science"
  - Feel confident that they could talk with other people about how technology is used in citizen science projects

> **"Getting that kind of prominent attention, on air and on the website, would be one of the most effective ways the field would have to bring knowledge about citizen science to people who haven't heard about it."**
>
> **- Project Advisor**

- In addition, the website was more effective in eliciting certain outcomes from users than the broadcast series. Compared to those who only viewed an episode, those who used the website were significantly more likely to:
  - Feel confident in their ability to contribute to meaningful scientific research and their ability to analyze and interpret data
  - Believe that anyone can be a scientist
  - Visit citizen science websites
  - Investigate citizen science projects in their local area and participate in citizen science projects in the future

Citizen Science Project Leaders' Perspectives on The Crowd & The Cloud's Broadcast & Digital Media

- Citizen science leaders whose projects were featured in the series or on the website felt that The Crowd & The Cloud gave their projects additional recognition and legitimacy
  - While many promoted the show through their own organization's communication channels, a few struggled with how best to capitalize on the increased attention.
- Citizen science project leaders felt that The Crowd & The Cloud attracted new volunteers, and energized and validated their current volunteers
  - For example, after Episode One aired, EyesOnAlz's StallCatchers platform experienced its highest spike in new project participants (300+)

Project Advisors' Perspectives on The Crowd & The Cloud's Broadcast & Digital Media

- Project advisors were impressed by the scope of the series and the variety of different projects that were featured
- Project advisors thought that The Crowd & The Cloud's multimedia approach was effective. They felt that The Crowd & The Cloud broadcast and digital media:
  - Increased the public's awareness of citizen science, and encouraged them to participate
  - Helped people see themselves as someone who can do citizen science and empowered individuals to use citizen science to address community issue
  - Represented issues around data quality in citizen science fairly

> **"As someone who's been watching the citizen science phenomenon grow and grow and grow, to bring it to new audiences and certainly get it in people's living rooms was much needed."**
>
> **- Citizen Science Project Leader**

Concluding Thoughts

The Crowd & The Cloud series had a wide-reaching impact on viewers' understanding of, attitudes towards, and behaviors around citizen science. Each of the three target audiences were informed and impressed by the range of citizen science projects portrayed in the episodes and by the kinds of technologies that allowed for sophisticated data collection by non-scientists. Focus group participants and survey respondents sought out additional information about citizen science and projects featured in the episodes, with some transitioning "from viewers to doers," a shift that was a main goal of the project. Prior to watching the series, members of the general public were largely unaware of citizen science and the opportunities available to contribute to projects. Through engaging with the series, members of the general public came to understand that a wide variety of projects exist and that people like them are contributing as citizen science participants. Finding projects that matched their interests and skills was an influential factor in turning viewers into doers.

The Crowd & The Cloud's website and social media presence effectively provided users with additional information about citizen science and crowdsourcing, as well as ways to become more involved in citizen science initiatives. The information available on the website was designed to be utilized in conjunction with the broadcast episodes or to stand alone for users who had not yet watched the series. The website serves as a portal through which viewers who are motivated by the episodes can connect with citizen science projects and become doers.

The project's robust social media campaign supported both the broadcast series and the website. While the broadcast series and website are platforms that require viewers and users to engage first by watching the episodes or visiting the website, the project's social media allowed the series producers to push content directly to their followers across multiple platforms, such as Facebook, Twitter, and Instagram. In particular, posts that mentioned an individual or group affiliated with a citizen science project featured on an episode in the series or website, that appeared in conjunction with the television broadcast air dates, that had longer character counts, used more hashtags, and/or included colorful imagery or videos with little to no text tended to elicit the most user engagement. In this way, social media extended the reach of the project beyond what broadcast series or a website could otherwise do.

Thus, The Crowd & The Cloud's broadcast and digital media succeeded in making viewers aware of citizen science initiatives around the world, changed people's perceptions of citizen science, and motivated a new wave of individuals to engage in scientific research to fill in knowledge gaps, track trends using large datasets, or address problems within their local communities.

Project Description

Citizen science is a fast-growing movement in which everyday people are empowered to engage in scientific research. Through crowdsourcing (the process of obtaining information from a large number of people) and harnessing the power of mobile technology, everyday people can participate in and make substantial contributions to citizen science. The Crowd & The Cloud, a three-year project developed by Passport To Knowledge and funded by the National Science Foundation, uses multimedia (broadcast and web videos, a website, and several social media platforms) to engage different audiences around citizen science topics and highlight projects that use innovative technologies to collect and analyze scientific data. The project team created four episodes of a broadcast television series, an interactive website, and a robust social media presence in order to reach three target audiences: the general public, scientists, and citizen science participants. This report focuses on the use and impact of the broadcast series on viewers, and the website and social media on users.

The project team produced four episodes of The Crowd & The Cloud series for broadcast television (see Table 1). Each episode was hosted by former NASA Chief Scientist, Waleed Abdalati, and highlighted multiple citizen science projects across the United States and abroad, focusing on thematic areas, such as disease and public health, air and water quality, and preparation for and response to natural disasters. One of the main purposes of the episodes was to attempt to "turn viewers into doers." Several core messages about citizen science and crowdsourcing appeared across the four episodes in support of this goal, including:

- Anyone can do citizen science
- Citizens can use science to address issues relevant to their local communities and/or to inform policy decisions
- Data collected by citizens can be as valid and accurate as data collected by scientists
- Innovative technologies can be used to collect and crowdsource large amounts of information quickly and efficiently

Table 1. The Crowd & The Cloud Episode Descriptions

Episode Title	Episode Description
Episode 1: **Even Big Data Starts Small**	This episode introduces the concept of citizen science, and shows how scientific information can be crowdsourced, and how large datasets can be used to inform natural disaster planning and fill in knowledge gaps around disease. Projects featured in this episode include the Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS), OpenStreetMap, EyesOnALZ, and Public Lab
Episode 2: **Citizens + Scientists**	This episode highlights individuals who took action in their communities to mitigate air and water pollution. Projects featured in this episode include Philly Unleaded, Bucket Brigade, Trout Unlimited, and the Blue Map app.
Episode 3: **Viral vs. Virus**	This episode focuses on how citizen science and technology, such as smartphones, sensors, and social media, can be used to address global health challenges and improve public health. Projects featured in this episode include Propeller Health, West Oakland Environmental Indicators Project, Mosquito Alert, and Medic Mobile.
Episode 4: **Citizens4Earth**	This episode looks at how technology can be used by engaged citizens to gather data. Projects featured in this episode include Christmas Bird Count, Smartfin, World Bank, and several initiatives tracking phenomena such as pollinators, horseshoe crabs, monarch butterflies, and seasonal change in trees.

Episodes of The Crowd & The Cloud were broadcast on television or made available online, starting in April 2017. Televised episodes were distributed by American Public Television (APT) and broadcast on PBS stations across the United States and via WORLD Channel. Episodes were available online either via The Crowd & The Cloud website (CrowdAndCloud.org) or via PBS.org. Episodes accessible on The Crowd & The Cloud website were captioned in both in English and in Spanish, and included a Twitter feed with commentary, images, and web links to supplement the viewing experience (see Figure 1). Episodes broadcast via WORLD Channel ended with a live roundtable discussion, where viewers could submit questions to individuals whose projects had been featured in that episode (see Figure 2).

Figure 1. Screen Capture of Episode 1 and Twitter Feed on The Cloud & The Crowd Website

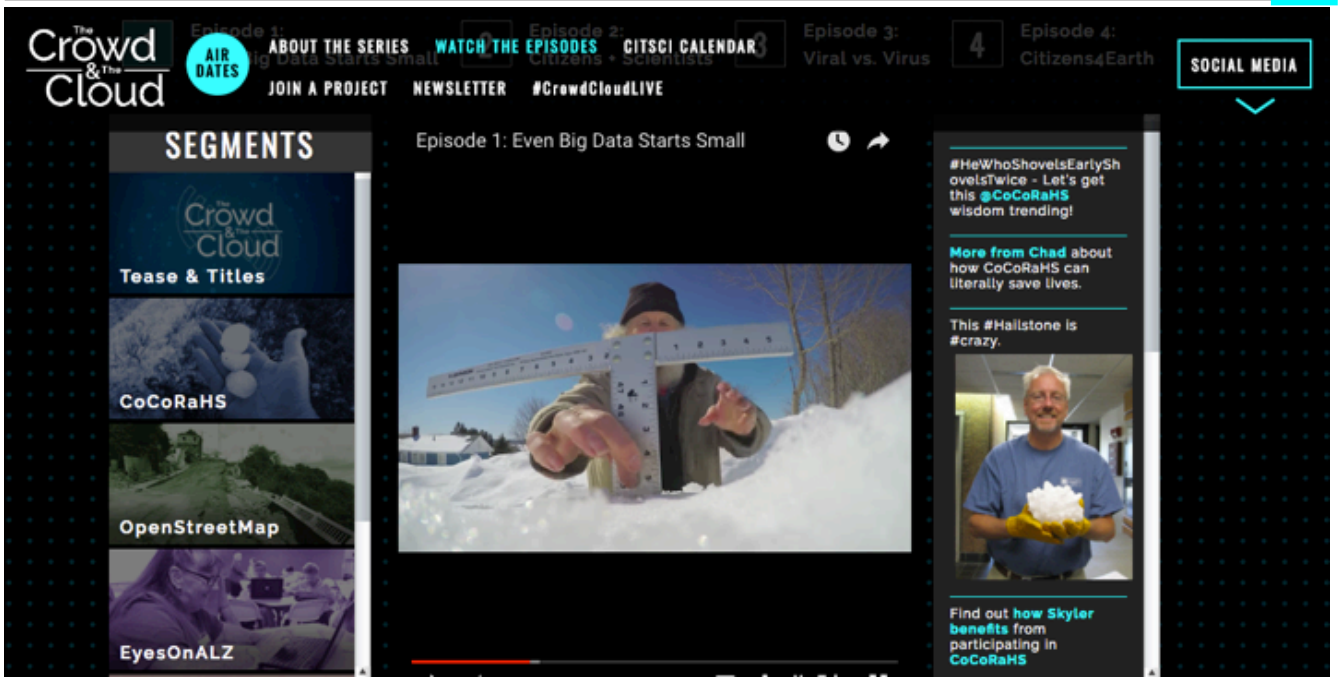
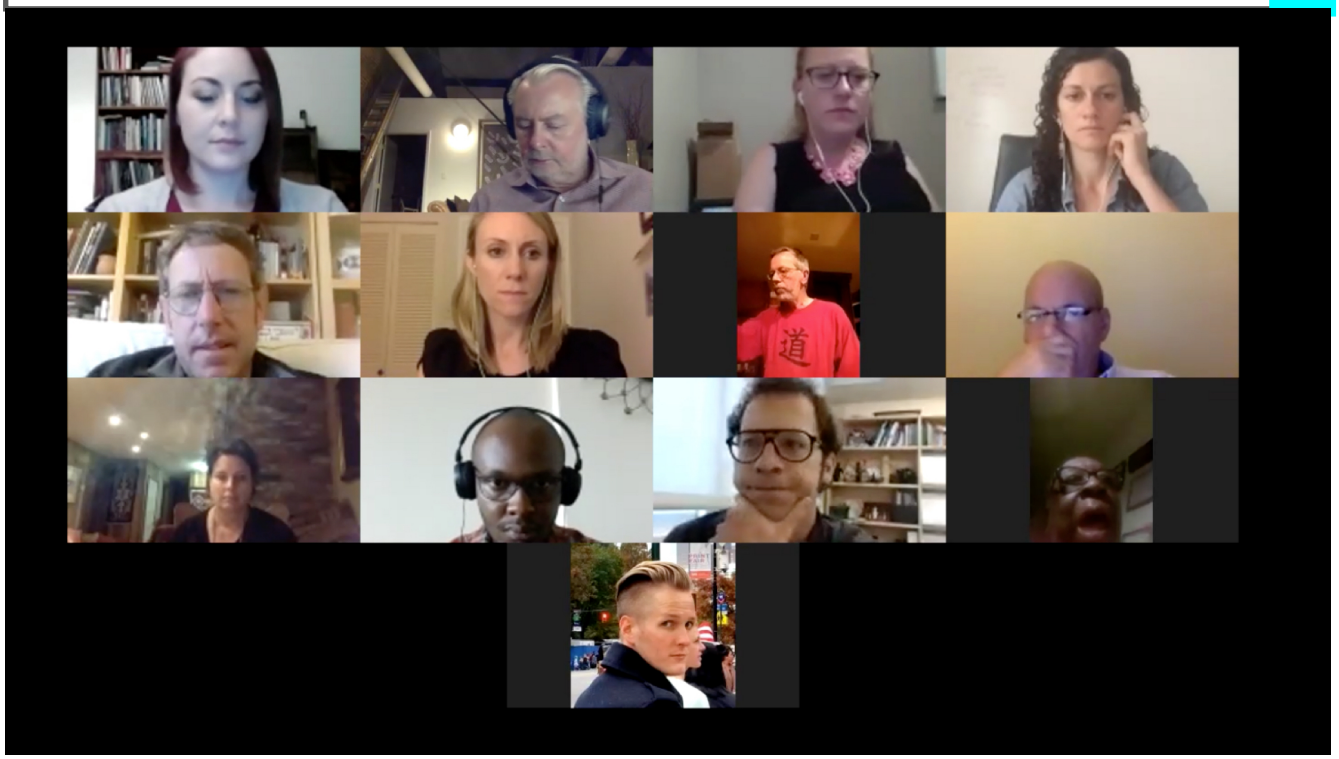


Figure 2. Screen Capture of WORLD Channel After-Episode Roundtable Discussion



The Crowd & The Cloud website was developed to allow for online viewing of the four broadcast episodes (“Watch the Episodes" section), to provide more information about the people and projects featured in the episodes (“About the Series" section), and to serve as a guidepost for “turning viewers into doers.”

The website highlights multiple citizen science projects across the United States and abroad that were featured in the episodes, and has searchable resources that participants can use to learn more about how to get involved in projects. SciStarter, an NSF-funded, searchable online database of citizen science projects individuals can join, partnered with The Crowd & The Cloud to help populate the “Join a Project” section on the project website. The SciStarter search platform serves as a resource for finding out more information about citizen science projects by topic, type (online or in-person), method (data collection, analysis), or geographic area. Website users could also look up broadcast airdates or sign up for The Crowd & The Cloud newsletter to find out more information about the project, recent citizen science news, and upcoming events in which they could participate. An initial incarnation of The Crowd & The Cloud website debuted in Fall 2014, to provide basic information about the project during its development phase. A second version went live in early 2017, to support outreach by PBS stations around the series, and an updated, public-facing version of the website launched in early March 2017. This latter iteration of the website is the version examined within this report.

The project team also employed a suite of social media platforms to bring viewers to The Crowd & The Cloud episodes and core messages, and to spread awareness about current citizen science initiatives. Social media platforms utilized by the project include Facebook, Twitter, Instagram, and Medium[1] (see Figure 3). In addition to being available on each of the social media platforms, a social media scroll panel was incorporated into the website when it was relaunched in March 2017, enabling website users to view all social media content directly from The Crowd & The Cloud website.

Rockman et al (REA), an independent educational research and evaluation firm, conducted an external evaluation of The Crowd & The Cloud broadcast series, website, and social media. The purpose of the summative evaluation of the broadcast and digital media was to address the following questions:

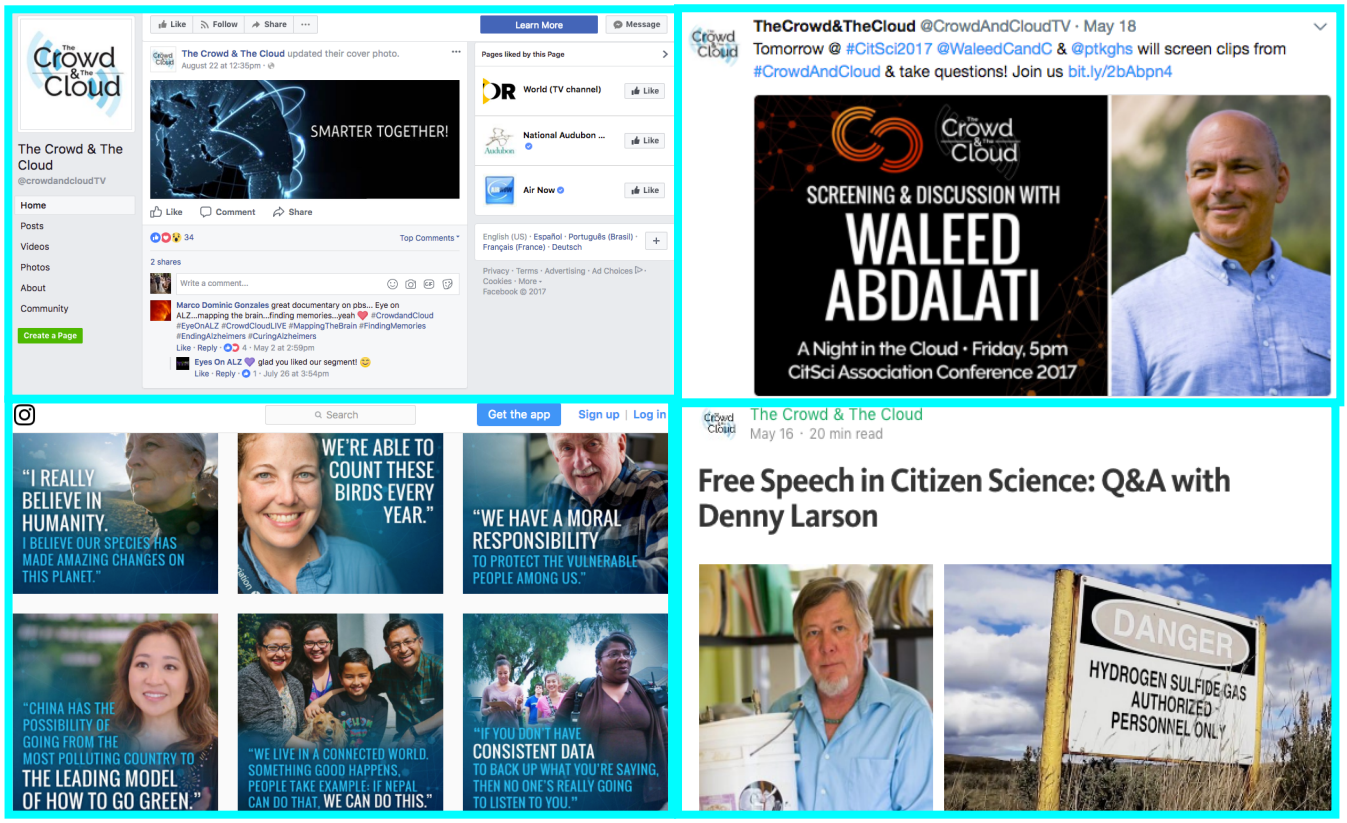
- How, where, when, why and with whom can media generate deeper involvement in citizen science?

[1] Online analytics were unavailable for Medium. Therefore, an analysis of Medium was not included in this report.

- Were specific media elements more effective than others in having an impact on participants?
- What is the cumulative impact of The Crowd & The Cloud's broadcast and digital media?

- How do viewers engage with The Crowd & The Cloud's broadcast series, website, and social media?
- What are the impacts of The Crowd & The Cloud's broadcast series, website, and social media on viewers' attitudes, behaviors, awareness of, and skills around citizen science?
- How do the impacts of the broadcast series differ by audience type (i.e., general public, scientists, and citizen scientists?

Figure 3. Screen Captures from The Crowd & The Cloud's Social Media Platforms



Methods

To examine the use and impacts of the broadcast series and website, REA distributed an online survey invitation in March 2017 to potential viewers before the episodes aired on PBS stations across the country. The invitations were distributed via citizen science organizations featured in the broadcast series, via SciStarter.com, and via The Crowd & The Cloud newsletter and social media. These venues were asked to send the invitations out again after at least one episode of the series had aired (April-June 2017). In addition, REA sent out survey reminders to participants who had filled out an initial survey. These efforts resulted in a large number of unmatched surveys from a mix of individuals who were exposed to the project in varying ways (see Table 2). This large dataset allowed for comparisons of series' impacts across the three target audiences[2]. In addition, 59 individuals completed both a before-series and an after-series survey. Their responses were examined for changes in understanding, confidence, and beliefs about citizen science over time, as a result of viewing an episode. Survey respondent demographics can be found in Appendix A.

Table 2. Description of Online Survey Sample*

	# of Total Survey Respondents
Did Not View Website or Broadcast Series	1222**
Broadcast Series Only	102
Website Only	70
Website + Broadcast Series	229

** Note: Respondents' social media use will be detailed in the Findings section of the report*
*** This number represents useful baseline data regarding individuals' awareness, understanding, beliefs, and behaviors around citizen science*

In addition, REA held in-person focus groups in four locations (Denver, CO; Philadelphia, PA; San Francisco, CA; and Oakland, CA) in June 2017 to gather more in-depth information on the impact of the episodes on viewers' awareness of, attitudes towards, and behaviors around citizen science[3]. In each city, REA recruited individuals from the series' three target

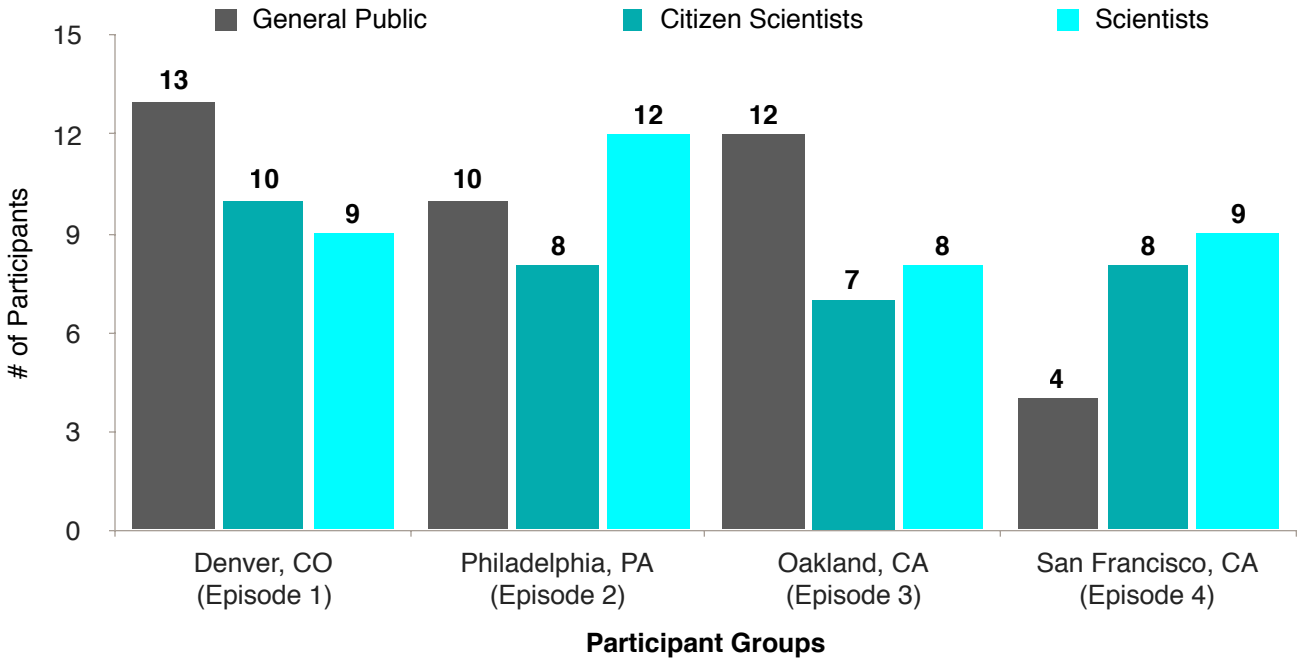
[2] The sample size was too small to do a similar comparison amongst website users.

[3] In-person focus groups were also held during the development phase of the project, using clips of individual segments and early versions of full episodes, to inform the structure and content of the final series.

audiences: the general public, citizen scientists, and scientists. Focus group participants were shown one episode of the series at each location, with the selected episode featuring a project local to that community (see Figure 4). Participant demographics for each location are detailed in Appendix B.

Individual telephone interviews were held with 10 members of the general public who signed up to participate in a citizen science project after viewing an episode of the series, and 13 citizen science project leaders to determine how the series impacted their and others' involvement in citizen science efforts. In addition, 12 advisors for The Crowd & The Cloud were interviewed to gather their opinions of the impact of the series on potential viewers and on the field of citizen science as a whole.

Figure 4. Distribution of In-Person Focus Group Participants



This report also incorporates feedback from four online focus groups, conducted in July and August 2017 via Google Hangouts[4]. Focus group participants (N=17) had all previously used The Crowd & The Cloud website, with some having explored the project's social media as

[4] In-person focus groups were also held during the development phase of the project to explore users' opinions about an early version of the project website and the content and format of potential Twitter messaging.

well. Focus group questions centered on participants' use of and thoughts about the project's digital media resources. Online focus group participant demographics are detailed in Appendix C.

REA analyzed online user behavior to better understand the impact of the project on audiences' engagement with The Crowd & The Cloud's website and social media platforms, both during and after the release of the episodes. This report focuses on The Crowd & The Cloud website and social media usage between March 1, 2017 and June 30, 2017. This timeframe encompasses the release of the updated version of The Crowd & The Cloud website, and the release of all four episodes of the series across PBS and WORLD Channel stations. The online analytics examine user traffic within the website, Facebook, Twitter, and Instagram pages, and provide information on how users navigated The Crowd & The Cloud website and interacted with the project's social media.

Findings

The Crowd & The Cloud Series' Viewers

Survey respondents[5] tended to find out about The Crowd & The Cloud via their local channel listings (see Table 3). Only a few (10%) just stumbled upon an episode of the series.

Table 3. How Viewers Heard About The Crowd & The Cloud (N=331)*

Method	% of Respondents
Channel listings	38%
Television announcement	30%
My job	18%
Family member/friend/colleague	12%
Mention on radio	11%
Website**	10%
Didn't hear about it before I watched it	10%
Other***	9%
Social Media**	5%

** Some respondents listed more than one method.*

*** Websites mentioned included: CoCoRaHS (66), local PBS station (6), scienceathome.org(1), SciStarter.org(1), and crowdandcloud.org(1). Social media mentioned included: Facebook (10), Twitter (3), and CIRES (1).*

**** "Other" responses included: PBS station newsletter/email (12), survey invite (7), email (6), PBS Station-general (2), ASME smart brief (1), (1), and CoCoRaHS (3)*

Most respondents decided to watch an episode because they like science documentaries and/or the topic of citizen science (see Table 4).

[5] The number of respondents (N=331) represents both those who only viewed the broadcast and those who viewed the broadcast and used the website.

Table 4. Reasons Viewers Watched The Crowd & The Cloud (N=331)*

Method	% of Respondents
I enjoy science documentaries	61%
I am interested in the topic of citizen science	56%
I received a notice from my local PBS station**	22%
My friend/family member recommended it	18%
I received a notice from another organization	8%
Other***	3%

** Some respondents listed more than one method.*

*** These communications may have been related to advertising the series itself or invitations to take the survey related to the series.*

**** "Other" responses included: CoCoRaHS (1), survey invite (8), ScienceAtHome (1), Daughter is a science teacher (1), By accident (1), and public television station (1).*

Survey respondents tended to watch episodes live on a local PBS station (see Table 5). Those who watched via WORLD Channel tended to view the live roundtable discussion afterwards (80%, N=75). Of these, most actively participated by submitting a question for the discussants to answer (93%, N=60). They also felt that the roundtable discussion had enhanced their viewing experience (95%, N=60), stating that it gave them a way to *"discuss and share experiences,"* and provided them with *"more anecdotes and some new ideas."*

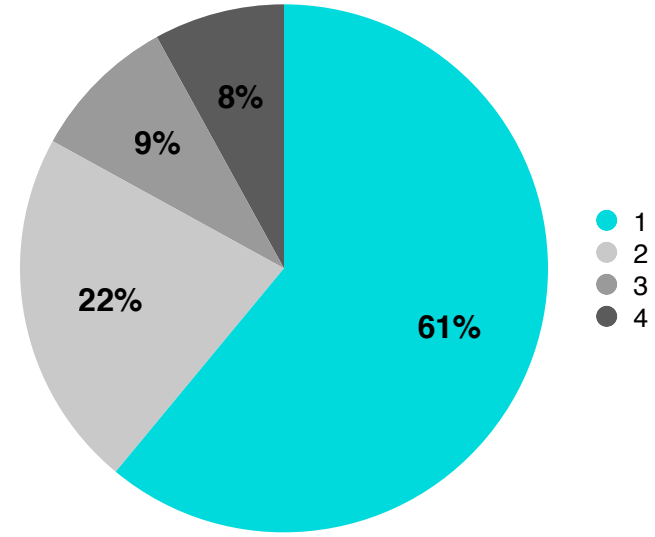
Table 5. Ways Viewers Watched The Crowd & The Cloud (N=331)*

Method	% of Respondents
Live on local PBS station	43%
Recorded it and watched it later	26%
The Crowd & The Cloud website	26%
Live on WORLD Channel	23%
Online via PBS.org	10%
Other**	3%

** Some respondents listed more than one method of viewing the series.*

*** "Other" responses included: REA focus group (5), Apple TV PBS app (2), Roku (1), University presentation (1), and PBS On Demand (1).*

Figure 5. Number of Episodes Viewed By Survey Respondents



Respondents who watched via The Crowd & The Cloud website tended not to notice the Twitter feed on the side of the screen, likely because it was not visible in full screen mode. Those that did (48%, N=85), tended to click on the web links within the feed (56%, N=41). Of those that saw the Twitter feed, the majority felt that it had enhanced their viewing experience (66%, N=41). Some felt that the Twitter feed provided more in-depth information that complemented the series: *"The notices piqued my interest to come back to dig deeper into the stories."* Some liked hearing others' thoughts and opinions on episode-related topics and accessing rich imagery: *"The photo of the dude holding a giant hailstone was fascinating."*

Regardless of how they viewed the episodes, most survey respondents only watched one episode before they took the survey (see Figure 5). Since participating PBS television stations were asked to send out survey invites at least twice (once after the first episode aired and once after all four episodes had aired), most of the respondents completed the survey after viewing Episode 1 and may have viewed subsequent episodes after taking the survey (see Table 6). Thus, it makes sense that when asked which citizen science projects stood out to them, survey respondents who answered the question (N=161) mentioned CoCoRaHS (32%), OpenStreetMap (22%), and EyesonAlz (20%) most often, which are all projects featured in Episode 1.

Survey respondents were also asked to share any follow-up activities they had done after viewing the series that extended their experience with The Crowd & The Cloud content (see Table 7). The majority of respondents (74%, N=331) did some type of follow-up activity. The largest number of respondents talked with friends and family about citizen science initiatives, looked up The Crowd & The Cloud on social media, or visited the website to explore an organization featured on the episode they saw. One respondent shared, *"[I] encourage others to sign up. I've shared the link already, and just finished watching a few minutes ago."*

Table 6. Specific Episodes Viewed By Survey Respondents (N=331)*

Episodes	% of Respondents
Episode 1: **Even Big Data Starts Small**	67%
Episode 2: **Citizens + Scientists**	46%
Episode 3: **Viral vs. Virus**	29%
Episode 4: **Citizens4Earth**	22%

** Some respondents listed more than one method of viewing the series*

Table 7. Survey Respondents' Follow-Up Activities After Viewing an Episode (N=331)*

Activity	% of Respondents
Talked with friends/family about citizen science initiatives	36.9% (n=122)
Checked out The Crowd & The Cloud on social media	29.9% (n=99)
Visited website for an organization featured on The Crowd & The Cloud	29.0% (n=96)
None of the above	25.7% (n= 85)
Searched for more information on citizen science projects	25.1% (n=83)
Searched for a citizen science project to get involved in	17.5% (n=58)
Talked to a citizen scientist	16.6% (n=55)
Signed up for The Crowd & The Cloud newsletter	16.3% (n=54)
Increased or renewed your involvement in a citizen science project you've participated in before	13.0% (n=43)
Visited SciStarter.com	12.1% (n=40)
Signed up for a citizen science project	8.5% (n=28)
Engaged with The Crowd & The Cloud or citizen science in another way	4.8% (n=16)

** Some respondents listed more than one activity.*

Of the respondents who indicated that they had signed up for a citizen science project, 79% stated that the episodes had inspired them to get involved. One respondent thought, *"I could get a rain measuring device and participate in that [CoCoRaHS] program."* Thus, the broadcast episodes encouraged viewers to continue interacting with citizen science topics, media, and initiatives, suggesting an impact beyond the initial viewing experience.

Impacts of the Broadcast Series – Across All Audiences

Awareness and Understanding of Citizen Science and Crowdsourcing

Matched survey responses were compared (i.e., the same individual took a survey both before and after viewing an episode of the series) to examine whether The Crowd & The Cloud series changed viewers' awareness and understanding of the concepts of citizen science and crowdsourcing. Due to the small sample size (N=59), matched respondents were not divided further into the three target audiences (general public, scientists, and citizen scientists), but rather examined as a group overall. This group includes those who watched an episode of the series and viewed the website (N=40) and those who only watched an episode of the series (N=19).

Survey respondents were asked to indicate their level of familiarity with the terms, "citizen science" and "crowdsourcing" on a scale from 0 to 4, with 0 being "Not at all familiar" and 4 being "very familiar." After watching at least one episode, matched survey respondents felt significantly more familiar with the concepts of citizen science and crowdsourcing (see Figure 6). Respondents were also asked to provide their own definition for what they thought citizen science is. Their answers were thematically coded, and two interesting differences emerged. After watching at least one episode, matched survey respondents were significantly more likely to mention data collection, $t(42)= -2.673$, $p=.011$. They were also significantly more likely to reference the role of professional scientists after watching an episode than they had before viewing, $t(42)= -2.203$, $p=.033$. The following are a few examples of respondents' answers before and after viewing at least one episode:

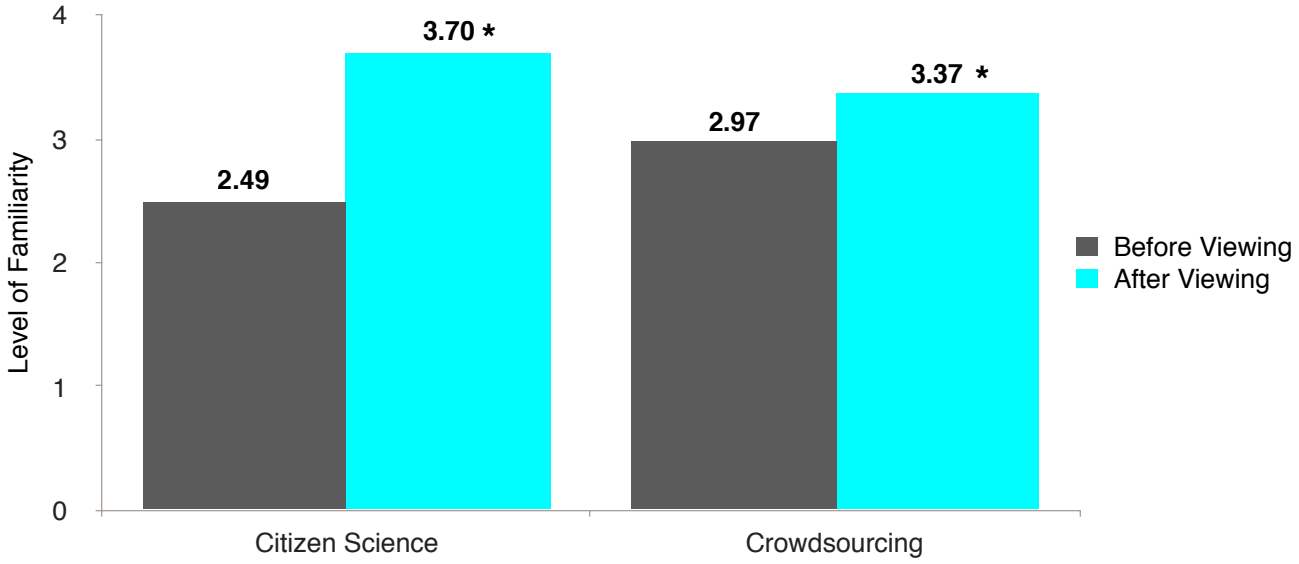
> **Before:** *Taking advantage of the work of serious hobbyists.*
>
> **After:** *Using interested general public to collect data, speeding up projects and making them more efficient.*
>
> **Before:** *Engaging regular folks - non-scientists - in scientific activities.*
>
> **After:** *Ordinary people collecting data from their observations and sharing their data with professional scientists.*

Before: *Awareness and participating, when feasible, in on-going science issues. Promoting science to friends, colleagues. Keeping informed on current issues - climate change, e.g.*

After: *Everyday, non-professionals gathering data on a large scale that is then used by professionals, providing data that otherwise a small group of scientists would have trouble getting.*

In the examples above, before watching an episode, respondents tended to either think that citizen scientists were not everyday people (i.e., "serious hobbyists") or they thought that everyday people might do science experiments or think about science issues. After watching at least one episode, they were more likely to reference the general public and how data they collect can be used.

Figure 6. Matched Survey Respondents' Familiarity with Citizen Science and Crowdsourcing Before and After Viewing an Episode (N=59)



** Indicates a significant difference at the p< .05 level.*

Survey respondents were also asked to indicate which projects or initiatives come to mind when they think of crowdsourcing. As before, their answers were thematically coded, and two significant differences were found. After watching at least one episode, matched survey respondents were significantly less likely to state that they were "not sure" or "did not have an answer," t(56)= 2.179, p=.034. However, they were significantly more likely to reference

citizen science projects and collecting scientific data after watching an episode than they had before viewing, t(56)= -3.790, p=.000. The following are a few examples of respondents' answers before and after viewing an episode:

> **Before:** *Kickstarter, online help groups, such as chatrooms.*
>
> **After:** *Bird counts.*

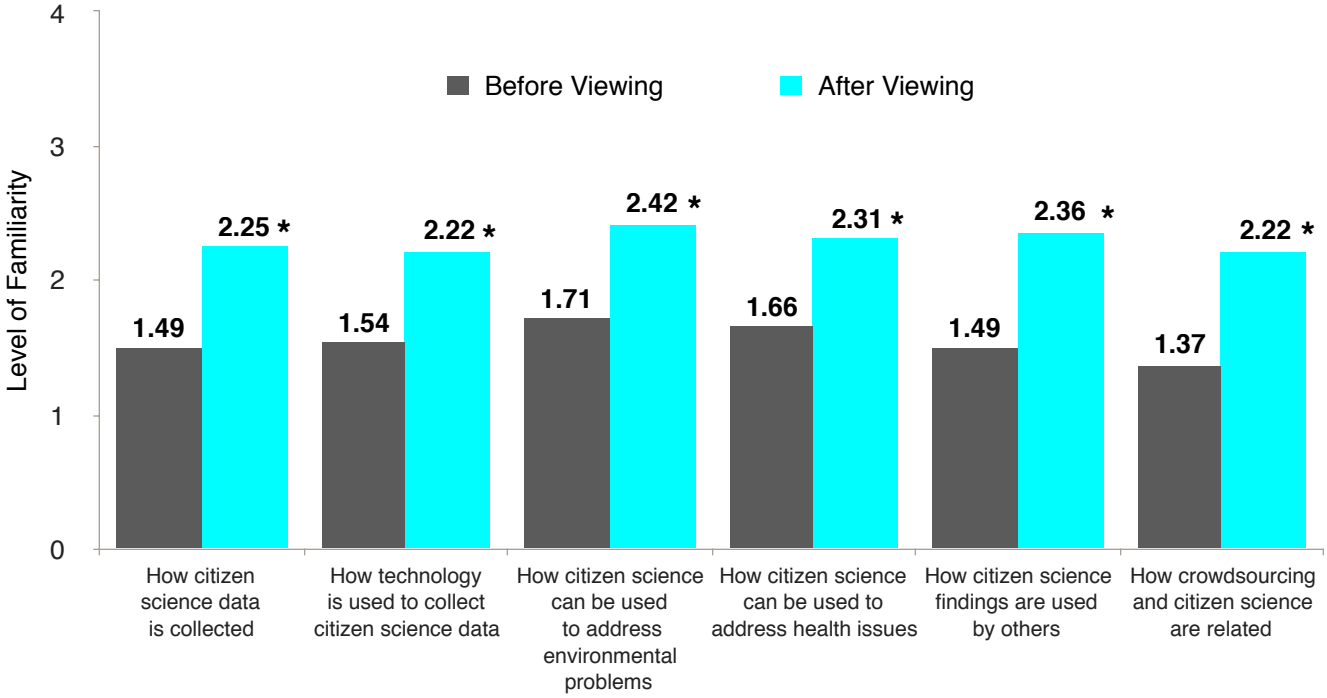
> **Before:** *This could be wrong, but I usually think of this more in fundraising terms. Someone has an idea or project they want to implement or a cause they want to raise money for and they start a Kickstarter campaign or something like that.*
>
> **After:** *Prior to watching the film, what came to mind had more to do with fundraising (GoFundMe, Kickstarter, etc.), however, now I realize it has more to do with gathering large amounts of data from individual citizens for weather monitoring, wildlife monitoring, etc.*

> **Before:** *Fundraising or park cleaning, river clean up, getting others involved, planting milkweed, planting trees, removing invasive species.*
>
> **After:** *Now, I know it's things like CoCoRaHS, NWS field observers.*

Note that although many respondents came to incorporate citizen science-related activities into their notion of crowdsourcing, some still included crowdfunding or information-gathering efforts (i.e., Yelp reviews, Waze, etc.) into their definitions of the concept.

Survey respondents came to better understand the intricacies of citizen science after viewing an episode of The Crowd & The Cloud. After watching at least one episode, matched survey respondents were significantly more likely to agree that they understood how citizen science data is collected, how technology is used to collect citizen science data, how citizen science can be used to address environmental problems and health issues, how citizen science findings can be used by others, and how citizen science and crowdsourcing are related (see Figure 7).

Figure 7. Changes in Matched Survey Respondents' Understanding of Citizen Science After Viewing an Episode (N=59)



** Indicates a significant difference at the p< .05 level.*

Attitudes Towards Citizen Science

Beliefs About Citizen Science

After viewing at least one episode, matched survey respondents were asked what they found out from the series and the main messages they took away after viewing. Their responses were thematically coded to determine whether viewers had any shared takeaways. The most common theme was that normal people can contribute to citizen science (76% mentioned, N=59):

"I don't need to be a scientist to engage in science data collection, and there are many ways for me to get involved."

- Program Viewer

Everybody can play a part, no matter what your concerns are.

I don't need to be a scientist to engage in science data collection, and there are many ways for me to get involved.

Everyone can be involved to help in making a difference. Science degree not required.

[I] didn't realize how many opportunities there were to participate in environmental data collection for the general population. As a matter of fact, I didn't realize there were any such opportunities…That with no science or statistical information background, I could contribute to research in these areas without even leaving the house.

In fact, when asked explicitly about this idea, matched survey respondents were significantly more likely to agree that anyone can be a scientist after viewing an episode of the series (see Figure 8).

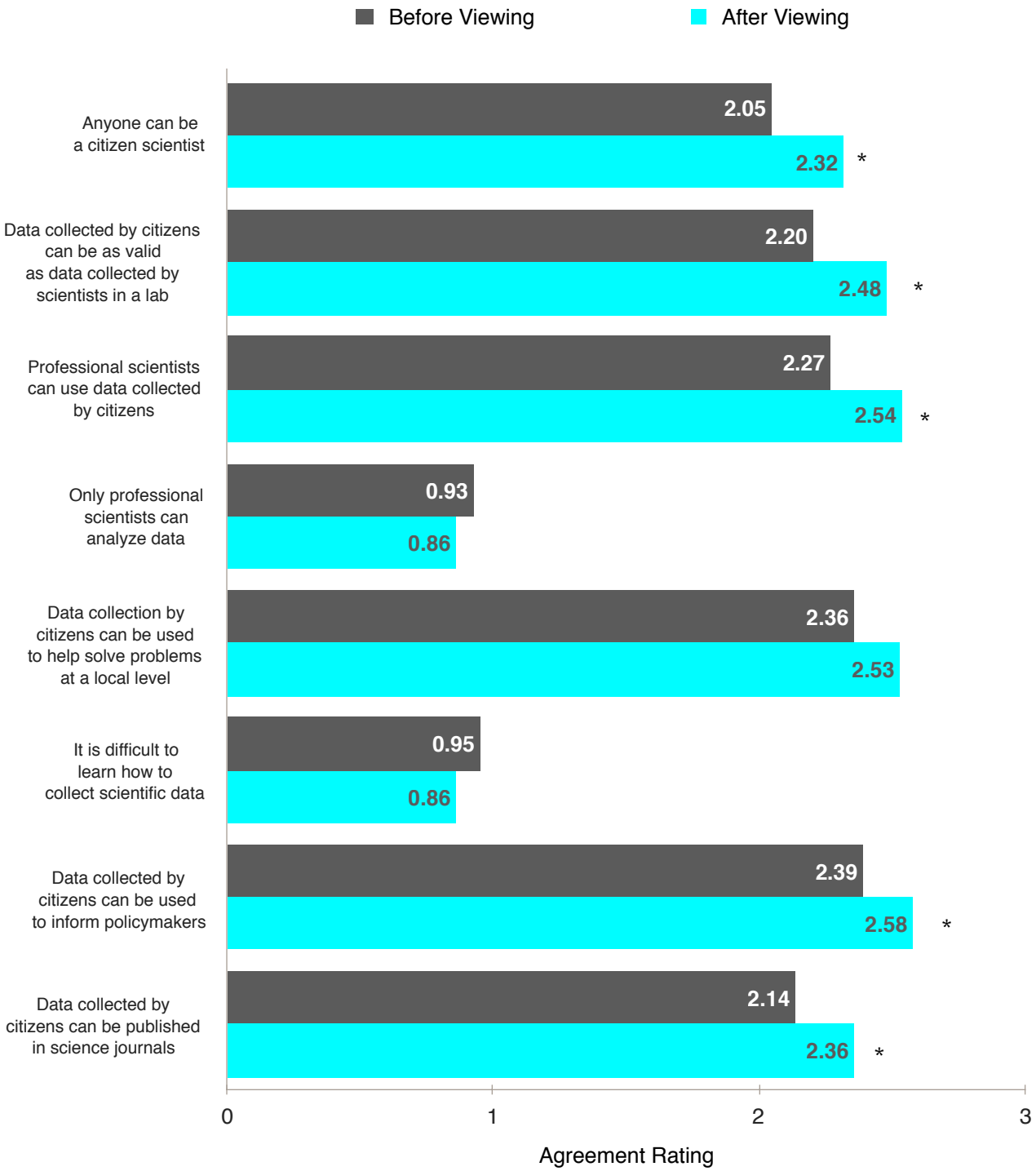
Similarly, matched survey respondents were significantly more likely to agree with the statement that data collected by citizens can be as valid as data collected by scientists in a lab after viewing an episode (see Figure 8). In their open-ended answers, over half (51%, N=59) of respondents mentioned that citizen science data are valid and useful in terms of collecting large amounts of data quickly: *"People who are not professional scientists can collect data with enthusiasm and precision, increasing the efficiency of many studies and projects."* Some respondents were also surprised at the diversity of projects that were highlighted throughout the episodes (41% mentioned in their open-ended responses): *"My idea of a citizen scientist was way short of all the possibilities for people to volunteer. Huge variety of fields to choose from, totally blew my mind. Looking forward to watching the rest of the series."*

"It is possible to help your own neighborhood by participating in science."

- Program Viewer

Viewers also saw ways that scientists could utilize data from citizen scientists: *"Crowd science can also generate more data more quickly than experienced scientists could, giving the experienced scientists more time to analyze and utilize the data."* After watching at least one episode of the series, matched survey respondents were significantly more likely to agree that professional scientists can use data collected by citizens (see Figure 8). They also were more likely to agree that such data can be published in scientific journals, an outcome that was highlighted in Episode 2 of the series when members of the Bucket Brigade published a peer-reviewed article based on their air quality data. One respondent, a former scientist, saw value in citizen scientists' contributions: *"The advent of using citizen scientists is important and appreciated by the scientific community. As a retired trained scientist myself, it is interesting and beneficial to see how science has moved out of the 'ivory tower' and into the mainstream through crowdsourcing and other methods."*

Figure 8. Matched Survey Respondents' Beliefs About Citizen Science Before and After Viewing an Episode (N=59)**



** Indicates a significant difference at the p < .05 level*

*** On a scale from 0 to 3, with 0 being "Strongly Disagree" and 3 being "Strongly Agree"*

Although there were no significant differences in their level of agreement with the statement, many viewers felt that citizens can use scientific data to address local problems:

> *The range of problems that can be solved or at least mitigated by taking advantage of citizen science and new technology.*
>
> *Impressed with the changes that citizens can make when they take charge, pleased for the citizens and scientists about changes that resulted.*
>
> *I had no idea of the level of participation ordinary people were working on reducing pollution due to a health problem…It is possible to help your own neighborhood by participating in science.*

However, viewers were significantly more likely to think that citizen-collected data could be used to inform policymakers after watching an episode of the series (see Figure 8). Some also thought that citizens serve a watchdog function for corporations: *"The public is a great resource of policing big companies."*

Taken together, the closed and open-ended matched survey responses suggest that viewers did hold increasingly more positive beliefs about citizen science after viewing at least one episode of the series.

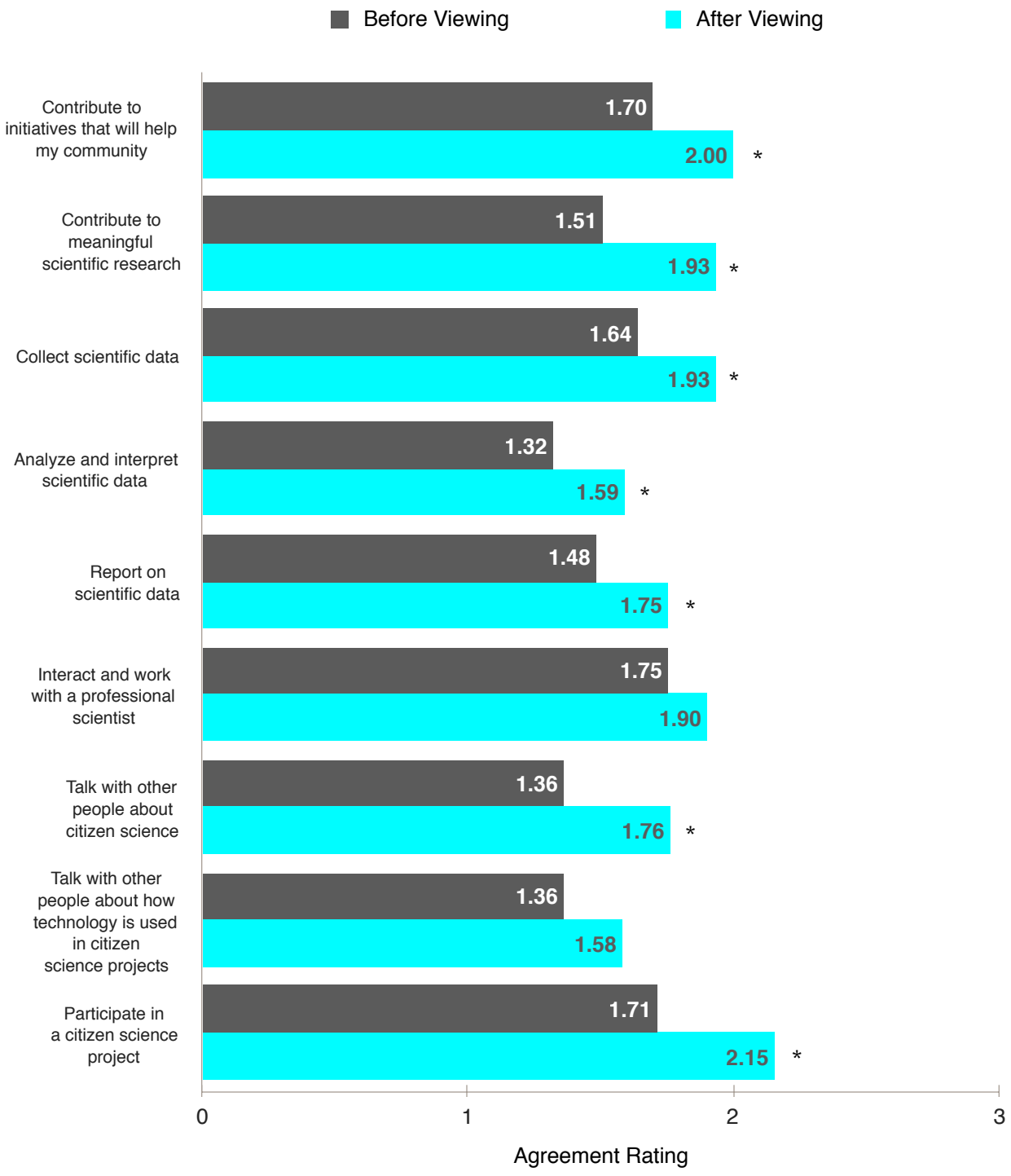
Confidence in Citizen Science Abilities

"Individuals can make a difference. Maybe there's something that I can help with."
- Program Viewer

After viewing an episode, matched survey respondents were significantly more likely to feel confident in their ability to contribute to initiatives that would help their community and contribute to meaningful scientific research (see Figure 9). They were also significantly more confident in their ability to collect, analyze, and report on scientific data, and to talk about citizen science with others. Furthermore, respondents reported having significantly more confidence in their ability to participate in a citizen science project in the future than they had before viewing an episode of the series (see Figure 9). In fact, several respondents (22%) expressed enthusiasm for getting involved in a citizen science project in the future in their open-ended responses:

> *I should get involved! Looks easy and fun!*
>
> *Individuals can make a difference. Maybe there's something that I can help with.*

Figure 9. Matched Survey Respondents' Confidence in Their Citizen Science Abilities Before and After Viewing an Episode (N=59)**



** Indicates a significant difference at the p < .05 level*

*** On a scale from 0 to 3, with 0 being "Strongly Disagree" and 3 being "Strongly Agree"*

Thus, it seems that the episodes did have a positive impact on viewers' confidence in their ability to do citizen-science related activities.

Interest in Related Topics

Watching an episode of the television series positively impacted viewers' interest in a variety of topics (see Table 8). All survey respondents who viewed at least one episode were asked to indicate whether the series increased or decreased their interest in specific topics on a scale from 0 to 4, with 0 being "Decreased a lot" and 4 being "Increased a lot". The percentage of respondents who answered "Increased a little" or "Increased a lot" can be found in Table 8 below. The largest percentage of viewers felt that their interest in how technology is used in citizen science had increased, although the majority of respondents indicated positive increases across all topics.

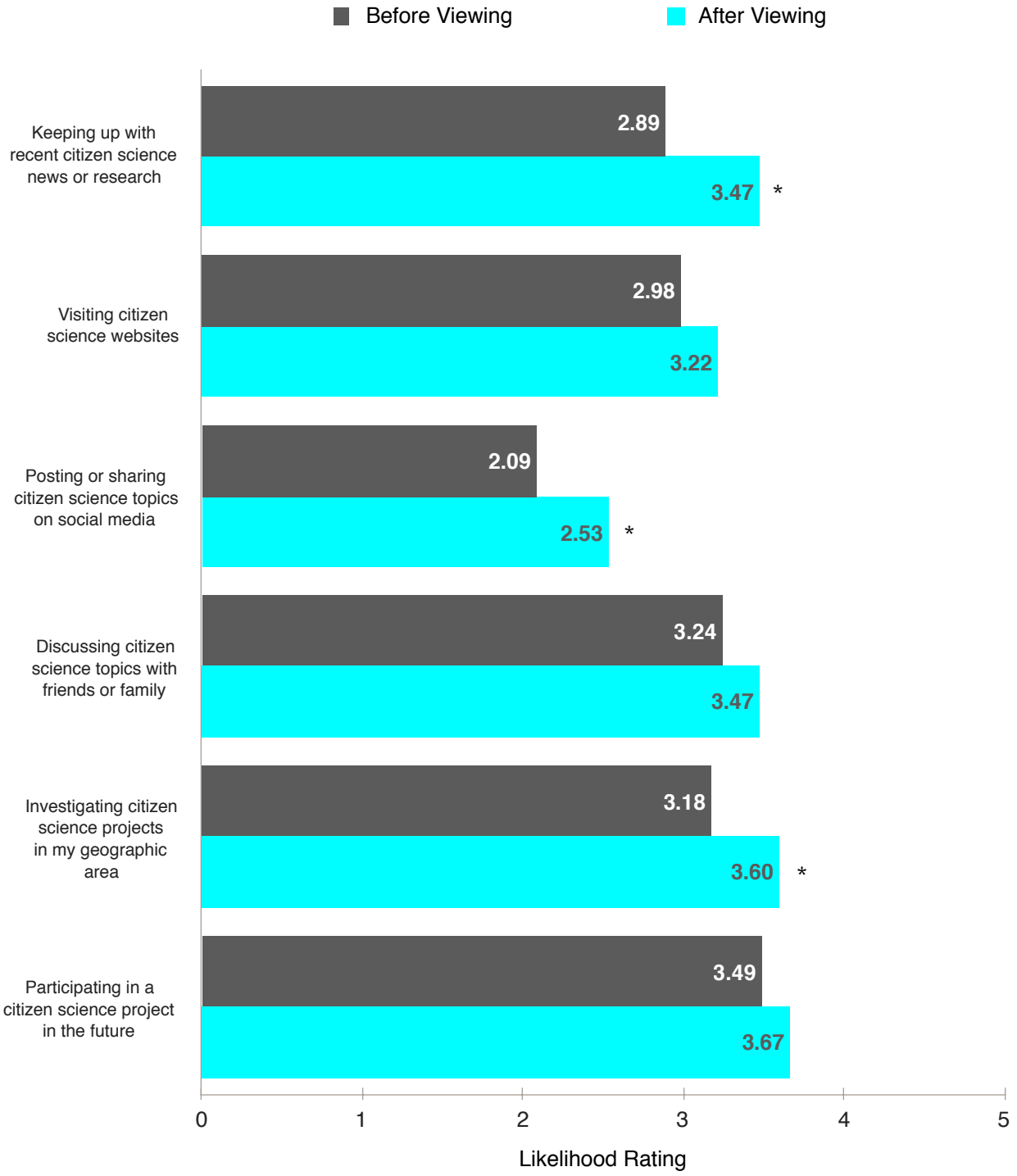
Table 8. Survey Respondents' Interest in Science-Related Topics After Viewing an Episode: Across All Audiences (N=271)

Topic	% of Respondents
How technology is used in citizen science	76%
Environmental topics	72%
Citizen science	70%
Scientific research in health and medicine	67%
Natural disaster response planning	65%
Geographic science	61%
Science, in general	57%

Participation in Citizen Science-Related Activities

After viewing an episode, matched survey respondents were significantly more likely to spend their free time keeping up with citizen science news or research, posting or sharing citizen science topics on social media, and investigating citizen science projects in their geographic area (see Figure 10). Although watching an episode did not impact the likelihood that individuals would participate in a citizen science project in the future, viewers did appear poised to engage with citizen science by gathering and sharing information about the topic, and looking up local citizen science projects online.

Figure 10. Matched Survey Respondents' Likelihood of Participating in Citizen Science-Related Activities Before and After Viewing an Episode (N=59)**



** Indicates a significant difference at the p < .05 level*

*** On a scale from 0 to 5, with 0 being "Not at all likely" and 5 being "Very likely"*

Summary of Impacts of the Broadcast Series Across All Audiences

Matched survey respondents who viewed one or more episodes responded positively to The Crowd & The Cloud series' content and presentation. After watching an episode, viewers expressed greater familiarity with and understanding of citizen science and crowdsourcing, had increased confidence in their ability to do citizen science, expressed interest in related topics, and were more likely to engage in certain citizen science-related activities, such as gathering information about citizen science, posting about citizen science on social media, and investigating citizen science projects in their local area. They also had more positive beliefs about who could collect data, the validity of that data, and how data can be utilized after watching an episode of the series.

These respondents provide a glimpse at the overall impacts of the episodes on viewers. However, what are the impacts of the episodes on specific audiences? The section below describes findings from the general public, scientists, and citizen scientists. Here, data from unmatched surveys (of those who either viewed an episode, or viewed an episode and went on the website) and in-person focus groups are examined in detail.

Impacts on Specific Audiences:

General Public, Scientists, and Citizen Science Participants

Awareness and Understanding of Citizen Science and Crowdsourcing

Data From Focus Groups

Data collected through in-person focus groups with the general public, scientists, and citizen science participants was used to gauge their awareness and understanding of citizen science and crowdsourcing. Prior to watching an episode of The Crowd & The Cloud, the majority of focus group participants from the general public were not familiar with the notion of citizen science. Across the four focus groups, less than a quarter of the general public (23%, N=39), had some familiarity with citizen science prior to watching an episode. After viewing an episode, one member of the general public from Mexico shared, *"This program gave me ideas of how to tackle problems in my home country with water pollution, air pollution. We don't have this concept of citizen science with these programs and strategies to tackle the pollution, so it gave me some ideas,"* (Episode 2). Another member of the general public linked crowdsourcing and citizen science together, *"I liked the point about having lots of inexpensive devices working on the problem being more effective than having one really*

expensive device. I think as members of the general public who want to get involved, that's a very refreshing and approachable message," (Episode 3).

Scientists were more familiar with citizen science than the general public. Nevertheless, only half (53%, N=40) of the scientists across the four focus groups were familiar with the concept of citizen science prior to viewing an episode. A few (N=5) had previously participated in citizen science projects themselves. Their participation ranged from tasks related to their jobs, such as organizing a citizen science project as part of their work at a museum, to collecting data as hobbyists, through participating in bird counts, submitting photos for a forest fire recovery project, or monitoring community air quality. Scientists in the focus groups also felt that the episodes helped them better understand the process and logistics of citizen science. One scientist shared, *"I actually understand how this is structured. This did feel like a legitimate project that could happen,"* (Episode 2). Other scientists in the focus groups appreciated how the episodes portrayed how volunteers (citizen scientists) are trained, and how the roles of the experts (scientists) and volunteers (citizen scientists) were clearly identified and explained throughout the episodes.

As one would expect, participants in the focus groups who self-identified as citizen scientists already had a baseline understanding of citizen science (100%, N=33). However, prior to watching the episodes, citizen science participants indicated that they hadn't realized how far-reaching citizen science is and how many different applications there are for citizen science participation. One participant who does citizen science with a local museum noted, *"Citizen science is way more broad than what I was thinking,"* (Episode 1). Watching the episodes also changed the way that citizen science participants in the focus groups thought about how technology can be used in citizen science: *"I loved how it talked about how your phone is a super computer. [The episode I viewed] made the connection with [how] using your phone can be beneficial. There is a lot of talk about how the millennial generation is obsessed with their phones and taking selfies. Maybe I can do something nice with my phone besides a selfie? I like how phones could be used for good,"* (Episode 1). Other citizen science participants expressed surprise over the varied mechanisms used to collect the data, such as the kites mounted with cameras featured in the Public Lab segment from Episode One. Although many citizen science projects incorporate digital technology, a few citizen science focus group participants had not previously considered how apps or mobile devices could be used to further data collection efforts of their own projects.

Data From Survey Respondents

When survey responses from those who had viewed an episode of the series were compared to those who had not, a few patterns emerged (see Table 9). Members of the general public who watched an episode of The Crowd & The Cloud report significantly greater familiarity

with citizen science, in general, than those who did not. Citizen science participants and scientists had similar familiarity with citizen science, in general, regardless of whether they viewed an episode or not. There were no significant differences in self-reported familiarity with crowdsourcing, regardless of whether they had viewed an episode or not, for all three audiences. However for all three audiences, those who watched an episode were significantly more likely to agree that they understood how crowdsourcing and citizen science are related than those who did not (see Figure 11).

Specifically, members of the general public and scientists who watched an episode were significantly more likely to agree that they understood how citizen science data is collected, how technology is used to collect citizen science data, how citizen science can be used to address environmental problems and health issues, and how citizen science findings can be used by others than those who had not watched the series (see Figure 11). Citizen science participants who watched an episode were significantly more likely than those who had not watched the series to agree that they understood how citizen science findings are used by others.

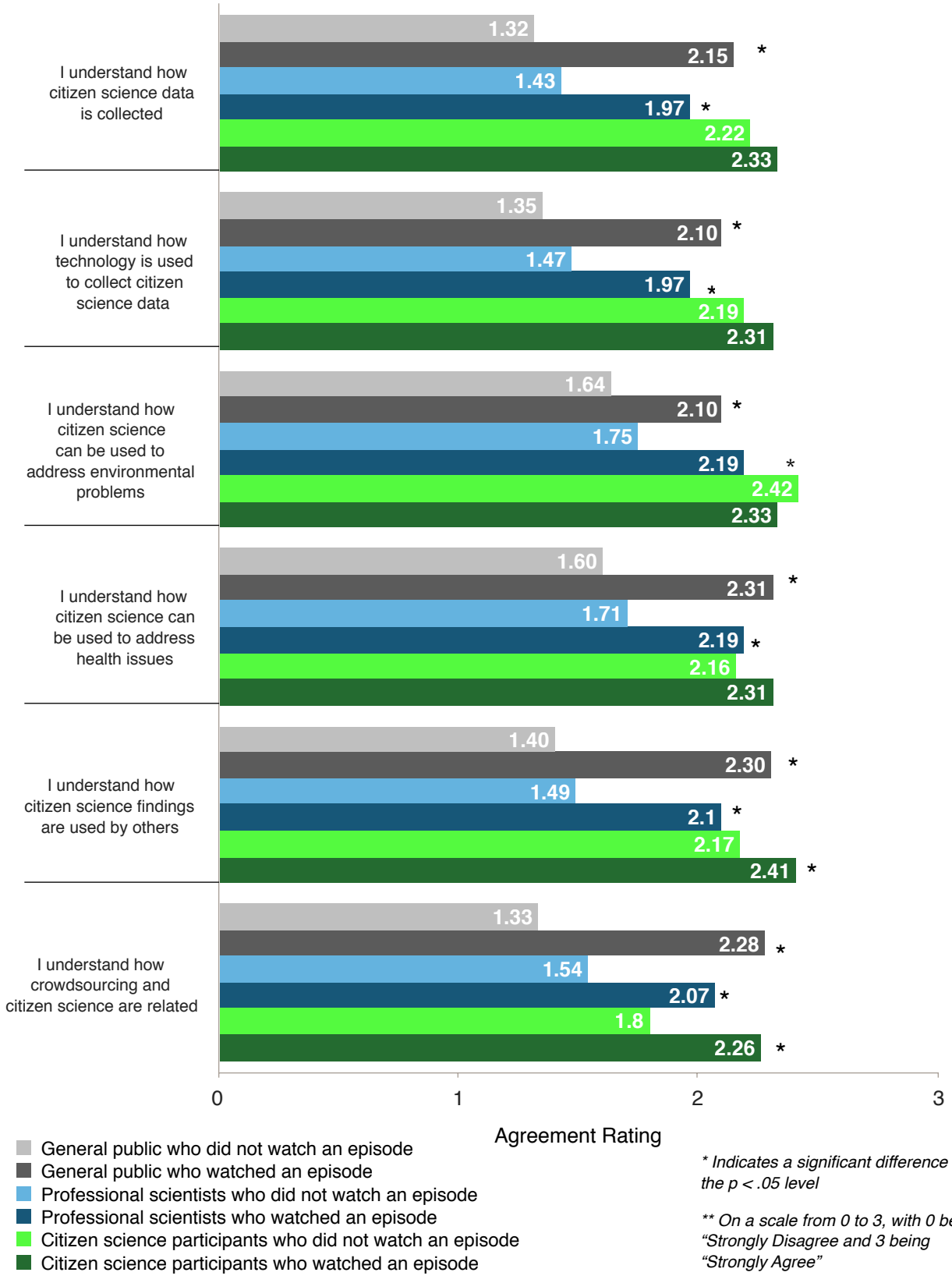
Table 9. Unmatched Survey Respondents' Familiarity with Citizen Science, Based on Whether or Not They Viewed an Episode**

Audience Type	Did Not Watch an Episode	Watched an Episode
General Public	2.18 (N=407)	2.79* (N=95)
Scientists	2.64 (N=114)	3.00 (N=31)
Citizen Science Participants	3.81 (N=153)	3.73 (N=51)

** Indicates a significant difference at the p < .05 level*

*** On a scale from 0 to 5, with 0 being "Not at all familiar" and 5 being "Very familiar"*

Figure 11. Unmatched Survey Respondents' Understanding of Citizen Science, Based on Whether or Not They Viewed an Episode**



** Indicates a significant difference at the p < .05 level*

*** On a scale from 0 to 3, with 0 being "Strongly Disagree and 3 being "Strongly Agree"*

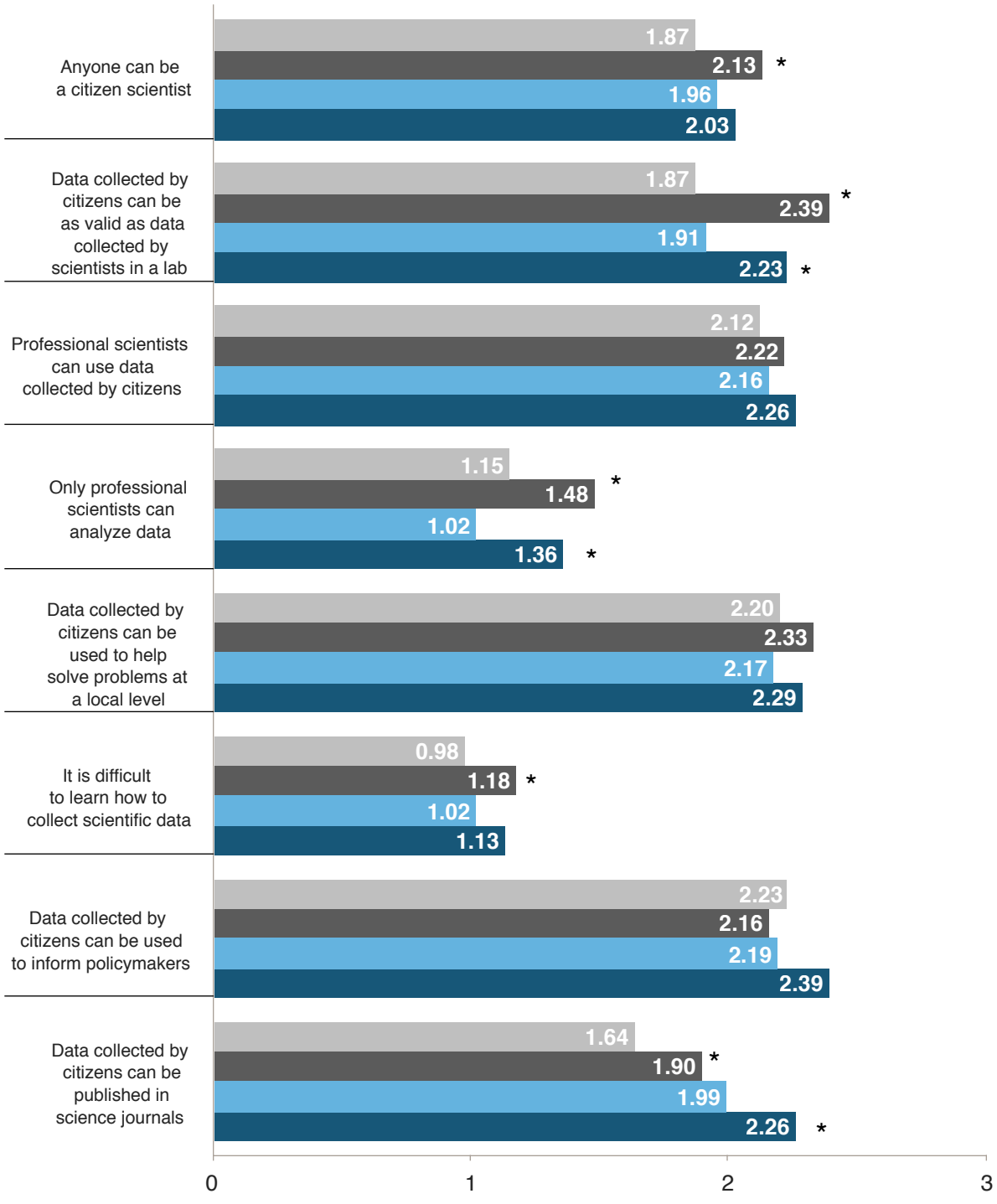
Attitudes Towards Citizen Science

Beliefs About Citizen Science - Anyone Can Do Citizen Science

In addition to introducing audience members to the concept of citizen science, the episodes made the general public more aware that they could participate in citizen science activities. Survey respondents from the general public who watched at least one episode were significantly more likely than those who had not watched the series to agree that anyone can be a citizen scientist (see Figure 12). One focus group member from the general public stated, *"Individuals can contribute and actually make a difference…in whatever area they choose. It never occurred to me that every single person, even a non-scientific person, can make a difference,"* (Episode 1). This sentiment, that citizen science is something that regular people can engage in, was echoed by other members of the general public: *"I think that sometimes the word 'science' or 'scientist' seems really scary to people. Like they might know more than them and I can't do what they can do, and it's really not like that. I like that the show showed it in a perspective to make people realize that it can just be something fun or it's something that really anyone can do,"* (Episode 2).

*S*urvey respondents who identified as professional scientists or as citizen science participants tended to agree with the statement that "Anyone can be a citizen scientist," regardless of whether they had viewed an episode of the series or not. For the most part, scientists had positive reactions to the episodes' content. One focus group scientist who was not familiar with citizen science beforehand stated that he had a more positive opinion of the premise after viewing an episode of the series. Scientists in the focus groups appreciated how accessible the episodes portrayed science as being. One scientist explained how the episode he viewed was *"knocking down this idea that science is an exclusive club, more inspiring that citizens can be part of it,"* (Episode 2). Another focus group scientist added, *"The program challenges what it means to do science…As a scientist, it's very, 'You have to do science in this way,' but with citizen science, it's doing stuff that anyone can do. You don't have to go through extensive measures to know what to do,"* (Episode 2). Citizen science participants in the focus groups also had positive reactions to the episodes. They appreciated that citizen science was portrayed as being simple, fun, and accessible. As explained by a citizen science participant, "*The program shows the power of being able to mobilize people. The key to citizen science is how to do that,"* (Episode 1).

Figure 12. Unmatched Survey Respondents' Beliefs About Citizen Science, Based on Whether or Not They Viewed an Episode**



** Indicates a significant difference at the p < .05 level*

*** On a scale from 0 to 3, with 0 being "Strongly Disagree and 3 being "Strongly Agree"*

Beliefs About Citizen Science - Difficulties in Learning to Collect Data

Although there were no differences for scientists or citizen science participants, survey respondents from the general public who watched an episode were significantly more likely to agree that it is difficult to learn how to collect scientific data than those who had not watched the series (see Figure 12). This may be due to the sophistication of many data collection methods shown throughout the four episodes, such as using surfboards with sensors attached or flying balloons with cameras. It is possible that having more knowledge about the intricacies of specific data collection processes may have made members of the general public question their own ability to collect potentially complex citizen science data. Regardless, focus group members from the general public still viewed citizen science as a way to make scientific practices accessible to ordinary people:

> *I think [citizen science] has the potential to democratize science.* (Episode 3)

> *I think [citizen science] is a great tool for outreach and getting people interested in knowing more about the scientific process, especially communities that have typically been underserved by the STEM community.* (Episode 3)

Beliefs About Citizen Science - How Citizen Science Was Portrayed in the Series

Citizen science participants in the focus groups were inspired and motivated by the projects featured in the episodes: "*For our organization, I feel like, 'Oh, man! We need to do a better job. Some people are doing amazing things and we are only doing so-so. We need to step up our game,"* (Episode 1). Focus group participants confirmed that the way citizen science was portrayed was similar to their own experiences. In particular, the process of collecting data in the episodes resonated with members of the citizen science focus group. One citizen science participant explained how the way she collects data is very similar to the way data was collected and portrayed in the Alzheimer's segment: *"At the science museum, the way we have people count papilla in the tongue and how it affects the way you taste certain things is the same process used in mapping the brain in the Alzheimer's segment,"* (Episode 1). Citizen science focus group participants, who saw Episode One of the series, which showcases elements of game design, suggested that incorporating elements of gaming into data collection activities was a clever way for participants to have fun and stay engaged, while also contributing information. They expressed a desire to incorporate these game-like elements into their own citizen science projects.

Beliefs About Citizen Science - Using Citizen Science Data to Inform Policy

Survey respondents from all three audiences, regardless of whether they had viewed an episode of the series or not, tended to agree that data collected by citizens can be used to

inform policymakers and can be used to solve problems at a local level (see Figure 12). Viewers saw citizen science as a valuable social policy tool. A scientist on the project's advisory board, who was individually interviewed, shared, *"You don't have to be a scientist to collect this data and stand up in government and tell them what the issues are."* A focus group participant from the general public elaborated upon this idea saying, *"Getting people together to act on a problem [is important]. Data collection is important, but it's a powerful tool to bring people together collectively,"* (Episode 3). In particular, the general public felt that citizen science gave them opportunities to participate in and have a say in addressing personally relevant community issues. In addition, focus group members from the general public thought that citizen science can help the public learn about the research process and how their tax dollars are being used. One member of the general public explained, *"There's a perception about research…millions of taxpayer dollars being wasted by egg-heads. But if taxpayers can get involved in the research, it will help them understand better,"* (Episode 1).

Citizen science participants in the focus groups saw citizen science as an opportunity for scientists to share their research with the public: *"[Citizen science] is also trying to tell the message about the science you are trying to do - to teach the public about your science. It is a great way to do that,"* (Episode 1). Citizen science was viewed not only as a way to inform the public about scientific research, but to also empower citizens to take action. A citizen science participant was struck by how the episode she watched captured this: *"When the community members, who might not be trained scientists, were talking about how it empowered them. Now we're providing hard data, not just complaining or giving anecdotes to politicians or policymakers,"* (Episode 3). While using citizen science to affect policy change was seen as a benefit to the approach of mobilizing everyday people to conduct scientific research, one citizen science focus group participant cautioned that participants in citizen science projects may feel misled or disappointed if their project doesn't create policy results: *"The difficulty is that citizens collecting scientific data want to see policy changes or action taken as a result of their work, but that's not what scientists do. Science is done for the sake of knowledge, but the step to action and change is a different thing,"*[6] (Episode 2). Thus, citizen science participants saw their process as a way for the general public to become engaged in the scientific process, but wanted to also be realistic about affecting change through policy making.

Citizen science participants across the focus groups thought the episodes were timely and relevant: *"Given the current climate we're all living in, in this moving away from science and not believing science, and having alternative facts and things like that, all the more reason to*

[6] Although a few projects featured in the series informed or changed local or state policies (e.g., In Episode 2, the Bucket Brigade's work was shown to impact New York State's fracking policy), this is not the goal of many citizen science projects.

try to make that evidence-gathering data collection, how it affects public policy, how it affects people, how it affects the climate, is even more important than it was a year ago," (Episode 4). In addition, citizen science was seen by focus group participants as a way to give voice to and lend support to scientists and scientific endeavors: *"There is a war on scientists right now. Unfair war since scientists are usually introverts anyway. Citizen science is a way that scientists could link to everyday people who could speak on behalf of them."* (Episode 1). Here, some types of citizen science projects were viewed by participants as leading to advocacy, as well as activities in their own right.

Beliefs About Citizen Science - Scientists' Use of Citizen Science Data

Survey respondents from all three audiences, regardless of whether they had viewed an episode of the series or not, tended to agree that professional scientists can use data collected by citizens. Focus group members from the general public specified that having greater numbers of people across a larger geographic area collecting data was of value to scientists because they could gather more data in a shorter timeframe. One member of the general public explained, *"I think [citizen science] gives more manpower– like if you are in a lab, there's probably a few people who are doing the research, but if you have people who are more involved, it helps take that burden and expedites the data collection process and enables the scientists to do more of the science that requires actual expertise versus the simple task that anyone can do,"* (Episode 2). A citizen science participant echoed this idea, stating that the role of citizen scientists is *"collecting data where scientists wouldn't be able to get to it, where it is too time-consuming to collect, or too geographically spread,"* (Episode 1).

"Getting people together to act on a problem [is important]. Data collection is important, but it's a powerful tool to bring people together collectively."

- Program Viewer

Scientists in the focus groups agreed that citizen science can be a great resource for furthering scientific research. One focus group scientist summarized, *"One of the points was that scientists are no longer alone. With smartphones and cameras, it's becoming easier to get an ordinary citizen involved, whether it's taking pictures or collecting data. That resource is untapped and it can be a very valuable method,"* (Episode 4). Scientists in the focus groups that viewed Episode 4 saw opportunities to incorporate citizen scientists into their own work *"depending on the complexity of the question,"* and if members of the general public were *"trained."* One professional scientist explained how she uses citizen science resources to

support her own research, *"As a researcher, I can't go to all of these places and collect data all at the same time. But if there's a group of people who can go out and do this work for me, that's wonderful,"* (Episode 4).

Focus group members from the general public saw citizen science as a way for scientists to conduct research that might not otherwise be funded. One participant from the general public explained, *"[Friends in academia] complain a lot about the research they would like to do that they think would be of greater benefit. They can't actually do [it] because no one will pay them to do it, whereas something like citizen science would actually decrease the cost of doing that kind of research a lot,"* (Episode 2). In turn, focus group participants from the general public thought that professional scientists involved in citizen science projects add legitimacy to the citizen science movement. As summarized by one participant from the general public, *"[It's a] hand-in-glove situation. Academia can help public, and public can help academia,"* (Episode 1).

Beliefs About Citizen Science - Role of Professional Scientists

Citizen science participants who were individually interviewed felt that professional scientists could play a range of roles in the citizen science movement. Some viewed professional scientists as project leaders: *"[Professional scientists] need to let the citizens know why they are doing the research, and they have to be leaders. They are the leaders, we are part of the team."* Others saw professional scientists as taking a monitoring role: *"[Scientists] are there to make sure nothing stupid is done, and to make sure if things are done, that they are monitored well."* Similarly, professional scientists who were individually interviewed saw multiple roles for themselves in the citizen science movement. One scientist felt that she was both a resource provider, and a mouthpiece to support the findings: *"I see my role as a scientist to have the tools they need to get the job done, give them everything they need to collect, analyze, and summarize the data. I see the need for scientists to come in when there is a disbelief by the government. There are times we scientists need to speak up and speak up for the citizens."* She also saw herself as quality control, *"Academics can take on a role to help guide citizens to make sure they collect samples in a way that is accurate."*

An incidental takeaway from the series was that both members of the general public and scientists who viewed at least one episode were significantly more likely to agree on the survey that only professional scientists can analyze data than those who had not seen the series (see Figure 12). Here, viewers had the impression that in most citizen science projects, citizens collect data and professional scientists analyze it. While this finding does not align with the actual goals of many citizen science projects, several focus group members perceived this division of responsibilities to be an advantage, giving both parties time to do the work that is most important to them. One scientist explained, *"[Citizen science] helps with*

data collection. That's what the whole show is showing. Regular citizens can go out and collect data. They wouldn't always have the tools or training to interpret it like a scientist, but it helps with collecting data for scientific research," (Episode 4). However, a few scientists thought the episodes' emphasis on data collection overshadowed other possible ways for citizen scientists to be involved: *"I think people can and do take a variety of roles in citizen science, and this show really emphasized the data collection,"* (Episode 4). Another scientist from the focus groups added, *"I have an appreciation for citizen science because it's not just data collection. What's shown (in the show) is just collection."* (Episode 4). This scientist later explained that one of the challenges in involving citizens in other roles in a citizen science project is that the length of that project can span many years, whereas a citizen may only participate once. Citizen science participants in the focus groups also expressed concern about the episodes' focus on data collection, rather than showing citizen scientists who also analyzed results: *"If participants don't see the purpose or the result of the citizen science project, then it is no fun being a data automaton,"* (Episode 1).

Beliefs About Citizen Science - Validity of Citizen-Collected Data

Some focus group members from the general public saw citizen science as a way of conducting unbiased research that was in the interest of the community. Other members of the general public raised concerns that citizen scientists could incorporate their own biases into data collection.

> *I did have a split-second concern about people potentially tainting data when people are trying to address a problem that they personally have in their lives. So, if you're trying to deal with pollution in your area, how easy is it for citizen scientists to say they see more trucks coming through their neighborhood than there actually are, in order to get some ordinance passed? I'm not saying that's the case, just using as an example. When you're working on one of these projects, what needs to happen to make sure there's enough data and everyone is held accountable for the accuracy of that data?* (Episode 3)

However, this opinion was the exception rather than the rule, as survey respondents from the general public who watched at least one episode were significantly more likely than those who did not view the series to agree that data collected by citizens can be as valid as data collected by scientists in a lab (see Figure 12). Furthermore, survey respondents from the general public who watched an episode were also significantly more likely than those who did not watch the series to agree that data collected by citizens can be published in scientific journals, an activity that was highlighted in Episode Two of the series. Thus, most members of the general public trusted the accuracy of data collected by everyday citizens.

Citizen science focus group participants felt that one of the roles of professional scientists is to verify the data collected by citizen scientists: *"I would like to see scientists paying special attention to the integrity of the data. There is going to be so much data collected, I want scientists to make sure that they are taking care that it is good data,"* (Episode 1). Yet there were no significant differences between citizen science participants who watched an episode and those who did not in terms of their beliefs about the validity of citizen-collected data or citizens publishing in scientific journals. One citizen science participant, who marks moving objects in photographs for scientists as part of the project, Planet Nine, was interviewed about his experiences, and shared his thoughts about the contributions of the everyday citizens: *"We can save professional scientists time by removing data that they don't necessarily need to analyze, but everyday people, non-scientists can. They can now spend time on the data that will further their research, not data that won't contribute. It speeds up the process."* To insure data quality, he added, *"Some things you have to be taught, but you don't have to go to a 4-year university to locate an animal or collect data about the environment and you don't have to be a professional scientist to do data analysis."* Another citizen science interviewee explained, *"Projects are trying to get people who are honest and interested and would do a thorough job. Try to screen out those that might not do as thorough or regular a job. You want people who are sincere to the project."*

Scientists in the focus groups were divided as to the accuracy of the data collected by citizen scientists. Some scientists thought data collected by citizen science participants could be as accurate and credible as data collected by a professional. One scientist noted, *"[The episode I watched] does a good job mentioning that it's pretty credible, and that they don't just take it as absolute truth. It might take more citizens to be as credible as a scientist, although you can't just take a thing and say that it's from a scientist and therefore it's true. You need a lot to trust it,"* (Episode 4). Survey respondents agreed with this sentiment, with scientists who viewed at least one episode being significantly more likely than those who did not watch the series to agree that data collected by citizens can be as valid as data collected by scientists in a lab, and that data collected by citizens can be published in scientific journals (see Figure 12).

Other scientists, specifically those in the focus groups, were more concerned about the accuracy of the data. One scientist who had previously used citizen scientist-collected data explained:

> *I use citizen science in my work mostly to help with data collection. But I have concerns about the quality of the data, and from experience, there's a lot of cleanup that needs to be done before [that] data [is] useable. So I have to weigh that against my time and how much data I'm getting out of it. But I think there is great value to the data, and the methods have to be clear.* (Episode 3)

Some focus group scientists put their concerns about data collection quality into context with the other options research scientists have available to gather data. These scientists noted that citizens are just as likely as scientists to be biased, and that preconceived notions or someone's mentality can bias data, whether they are a scientist or a citizen. One scientist working in academia explained the parallel between data collected by citizen scientists and data collected by undergraduates: *"It seemed like all the groups [featured in the program] had a leader or researcher who showed them what to do, so those people would be the ones telling them what to do. In that sense, it's the same as the undergrad research experience, where you have a PI or grad student showing you what to do in order to get reliable data,"* (Episode 4).

Taken together, these findings from the in-person focus groups and surveys support the idea that the general public, professional scientists, and citizen science participants believe that citizens and professional scientists can work together to advance scientific research.

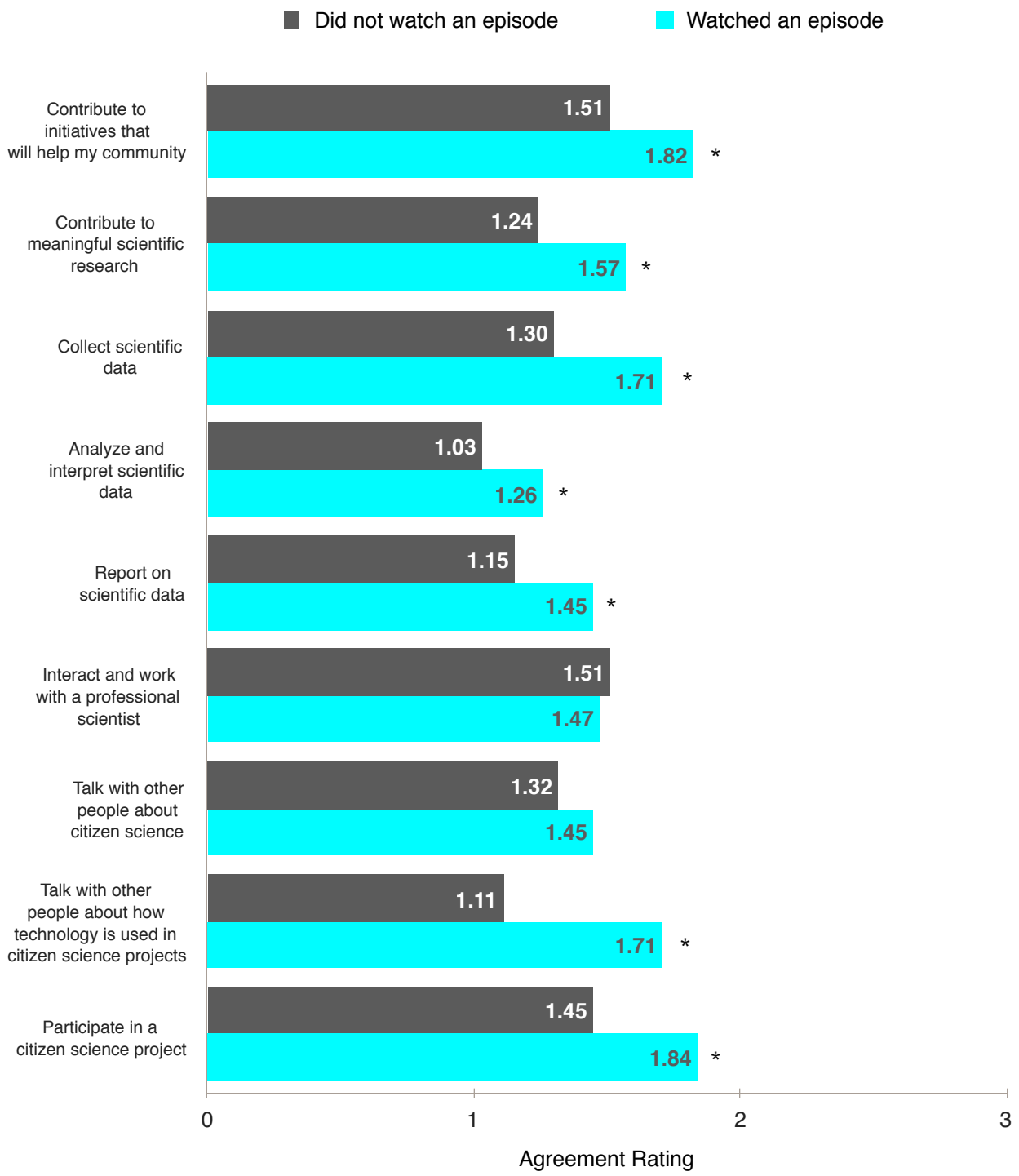
Confidence in Citizen Science Abilities: General Public

Although they believed that anyone can do citizen science, did members of the general public have confidence that they themselves could engage in scientific practices and contribute to citizen science initiatives after viewing the episodes? Survey respondents from the general public who watched an episode of the series were significantly more likely than those who did not see the series to feel confident in their ability to contribute to initiatives that would help their community and contribute to meaningful scientific research (see Figure 13).

Members of the general public who watched at least one episode were also more confident that they could collect, analyze, and report on scientific data, compared to those who had not viewed the series. While they didn't feel any more confident than those who had not viewed the series that they could talk with other people about citizen science, those who saw at least one episode did feel more confident discussing how technology is used in citizen science projects with others.

Overall, members of the general public who watched an episode of the series reported significantly greater confidence in their ability to participate in a citizen science project (see Figure 13). Similarly, almost all focus group participants from the general public agreed that viewing an episode had increased their level of confidence in their ability to contribute to citizen science projects: *"I think that [citizen science] is a tool to empower people through knowledge, getting them out there with people who feel confident in science and STEM… When you get people understanding the real world implications and realizing they can actually participate in solving important problems,"* (Episode 3). Thus, the episodes helped members of the general public feel like they themselves could do citizen science.

Figure 13. General Public Survey Respondents' Confidence in Their Citizen Science Abilities, Based on Whether or Not They Viewed an Episode**



** Indicates a significant difference at the p < .05 level*

*** On a scale from 0 to 3, with 0 being "Strongly Disagree and 3 being "Strongly Agree"*

In fact, during a telephone interview, individuals (N=10) who recently joined a citizen science project indicated that the series had increased their confidence in their ability to do citizen science:

> *Even though the subject matter was in-depth, the way people can contribute was easy. You really can help scientific research from a layman's interaction. I don't think I would have known how much was out there without having watched the episodes.*
>
> *The show did affect my confidence. It gave me more ideas of what I can do. It expanded my horizons. There are so many different things that I can participate in.*
>
> *Watching the show increased my confidence. I could see that there were older folks like me doing the projects.*

Interest in Related Topics

Table 10. Survey Respondents' Interest in Science-Related Topics After Viewing an Episode: Specific Audiences

Topic	% of General Public	% of Professional Scientists	% of Citizen Science Participants
How technology is used in citizen science	87%	87%	80%
Environmental topics	84%	74%	73%
Citizen science	78%	84%	86%
Scientific research in health and medicine	78%	77%	73%
Natural disaster response planning	76%	77%	75%
Geographic science	65%	71%	75%
Science, in general	61%	77%	69%

Viewing an episode of The Crowd & The Cloud had a positive impact on viewers' interest in a variety of topics (see Table 10). Survey respondents from all three audiences were asked to indicate whether the episodes increased or decreased their interest in specific topics on a scale from 0 to 4, with 0 being "Decreased a lot" and 4 being "Increased a lot". The

percentage of respondents who answered “Increased a little” or “Increased a lot” can be found in Table 10 above. The largest percentage of members of the general public and scientists felt that their interest in how technology is used in citizen science had increased, whereas the largest percentage of citizen science participants indicated that their interest in citizen science had increased. However, the majority of respondents from all three audiences indicated positive increases across all topics.

Scientists’ Thoughts About the Series

Scientists across focus groups found the content of the episodes that they watched to be interesting overall. However, they expressed some concerns about how science as a discipline was portrayed in the episodes. For example, more than one scientist thought that the episodes should focus more on data quality. As explained by one scientist, *“From the scientific view, I was looking at it – I liked the ideas. They were really good ideas. But I think they missed the point that troubleshooting [the data] is really important,”* (Episode 1). Other focus group scientists expressed concerns over how science was portrayed. These scientists were worried that the episodes simplified the scientific process: *“The first thing you learn about science in college is the scientific method. The Alzheimer's segment kind of touched on the scientific method, but for the most part it was left out. They didn’t show the detail of how they conducted the science, but I think that would have been too much for this program,”* (Episode 1).

Scientists were conflicted in terms of how much the episodes should focus on the specifics of the scientific process, versus being more general to keep different audiences engaged. A scientist in the focus groups summarized this tension saying, *“Obviously this isn’t an ‘information for scientists’ show. This is for the general public, and I think you can really easily still advocate for how science works by just saying, you know, ‘We did this validation thing,’”* (Episode 1). Scientists’ backgrounds led them to ask different types of questions and think about the themes of the episodes differently than the other two target audiences. Yet, overall, scientists found the episodes to be interesting and engaging.

Participation in Citizen Science-Related Activities

General Public

Members of the general public who watched an episode were significantly more likely to spend their free time keeping up with citizen science news or research, visiting citizen science websites, posting or sharing citizen science topics on social media, and discussing citizen science topics with friends or family than those who did not view the series (see Figure 14). They were also significantly more likely to spend their free time investigating citizen

science projects in their geographic area, and participating in citizen science projects in the future.

> **"There are so many different applications that could reach everyone from retirees to millennials. Everyone can contribute."**
>
> **- Program Viewer**

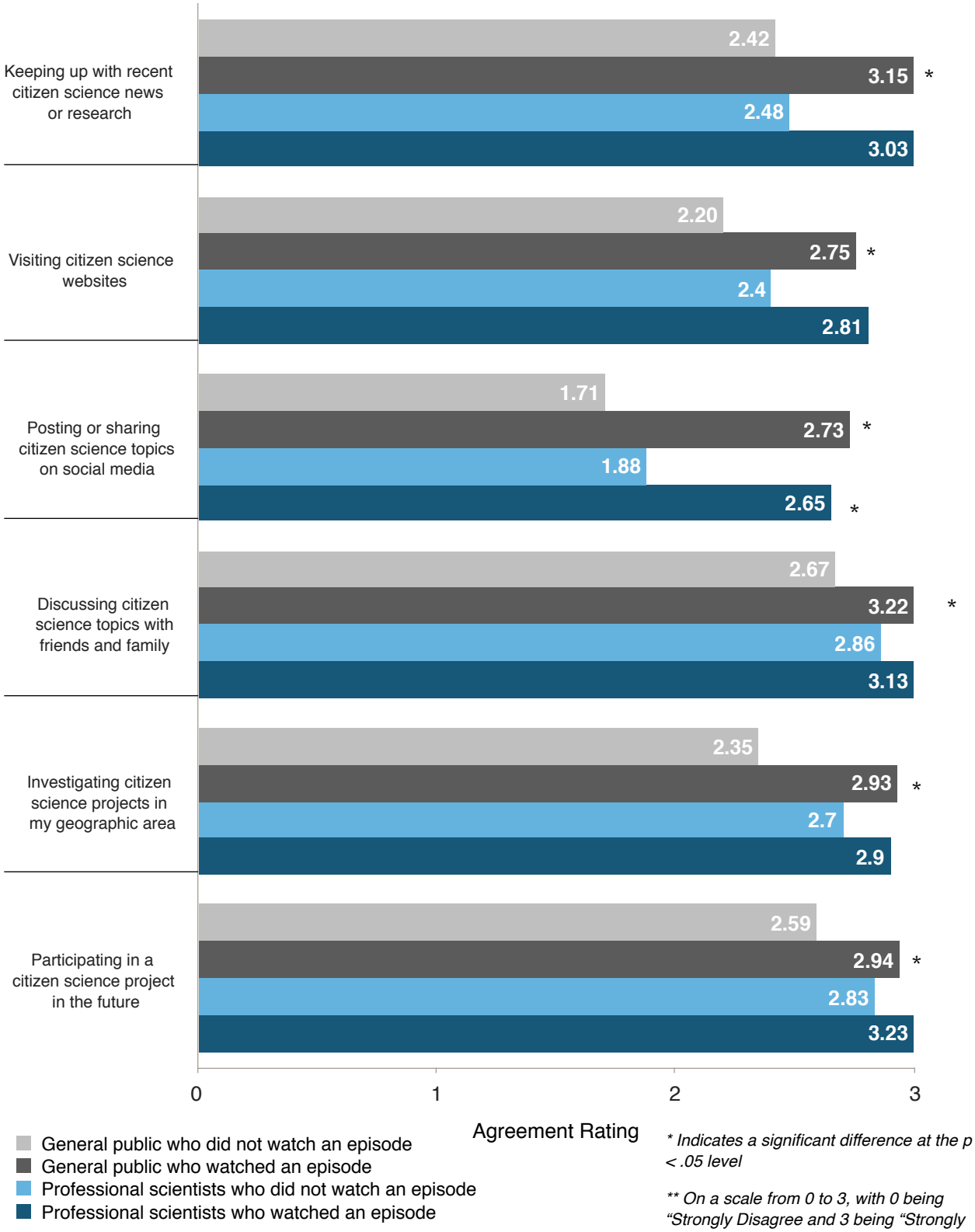
Similarly, across the four focus groups, 75% of participants from the general public (N=36) indicated that they were interested in participating in a citizen science project in the future, after watching an episode. Participants noted that they would go on The Crowd & The Cloud website to learn more about projects featured in the episodes and to potentially join a project. Members of the focus groups had wide-ranging personal interests, such as the environmental impact of fast fashion and reducing the amount of food waste in society, and wanted to pursue citizen science project ideas related to those interests.

Focus group participants from the general public liked that a diverse range of projects were highlighted in the episodes: *"There are so many different applications that could reach everyone from retirees to millennials. Everyone can contribute,"* (Episode 1). They appreciated that some of the projects featured in the episodes could be done at home on their computers. These participants thought online options made it easier to get involved and could see themselves contributing to a project in this manner. Other participants were drawn to projects that involved being outside and collecting data in the natural environment.

Focus group members from the general public could predominantly see themselves participating in citizen science projects as data collectors. A few participants saw opportunities to apply skills they already had to citizen science projects in roles besides data collection, such as communicating the project findings, conducting outreach to promote awareness and increase involvement, and doing analysis and statistics.

However, some focus group members from the general public were also cognizant of their own limitations, constraints and behavioral patterns. One individual indicated she was not likely to participate in a project saying, *"I'm already overcommitted to sort of activist things right now, so I'm not sure now would be the right time."* Another person who was not likely to participate acknowledged, *"I'm so lazy."* The tension members of the general public experienced between motivation and action was summarized by one focus group participant who stated, *"There's a difference between motivation and action. Did the show motivate me to learn more? Yes. Am I actually going to go and do something about it? Probably not,"* (Episode 3) Overcoming the inertia in people's lives is one of the key challenges for turning those motivated from viewing the episodes into active citizen science participants.

Figure 14. Unmatched Survey Respondents' Likelihood of Participating in Citizen Science-Related Activities, Based on Whether or Not They Viewed an Episode



** Indicates a significant difference at the p < .05 level*

*** On a scale from 0 to 3, with 0 being "Strongly Disagree and 3 being "Strongly Agree"*

Professional Scientists

There were no differences between professional scientists who watched the series and those who did not in terms of whether or not they chose to engage in citizen science-related activities. However, scientists who watched an episode were significantly more likely than those who did not to post about citizen science-related topics on social media (see Figure 14). In addition, scientists in the focus groups expressed interest in participating in a citizen science project in the future. They also saw opportunities for incorporating citizen science participants into their own work *"depending on the complexity of the question,"* and if members of the general public were *"trained."* One scientist in academia, who was individually interviewed, indicated that the series impacted the way she teaches: *"When I saw The Crowd & The Cloud, I was blown away. I felt like this was the future, and students need to get involved. I showed all of the episodes in my environmental public health policy class. The students loved it. The show inspired them to think differently about research, and how to create something meaningful."* This professor shared that the series also had an impact on how she thinks about communicating her own research: *"I started to think about how can we get the data we are collecting out to the citizens. Scientists are collecting water quality data all over the country. I just submitted a grant to the EPA to develop a model to help people predict their risk of lead exposure. I am trying to change the paradigm, so it isn't utility centric, but it is citizen centric instead. Using that to propel government to make decisions."*

Another academic researcher, who learned about The Crowd & The Cloud from a Citizen Science Association newsletter, said that for her, watching the series served as a call to action: "*How do I relate a complex thermodynamics problem to people's day-to-day lives?"* In her research, she is creating a game for everyday citizens that explores and collects data on turbulence and fluid mechanics. After seeing The Crowd & The Cloud, she has been thinking about how to give direct feedback to players regarding how they are contributing to the research: *"If you want people to keep contributing, you need to show them why they are important and why what they are doing is important."*

Citizen Science Participants

Citizen science participants who took the survey were likely to spend their free time engaging in citizen science-related activities, regardless of whether they had viewed an episode of the series or not. This is not surprising given the enthusiasm of citizen science participants for engaging in scientific practices and spreading awareness of the citizen science movement to others.

Ten individuals who joined a citizen science project after viewing an episode of The Crowd & The Cloud were interviewed regarding their experiences. Of these, six people had not heard

of citizen science before viewing the series. The other four had varying degrees of familiarity with the idea of citizen science. One participant who had not heard of citizen science before viewing, shared, *"The program made me realize that it is much easier to get involved than I thought previously."* Another interviewee stated, *"Citizen Science is doing a lot of positive and inspiring work, and I wanted to be involved…When my projects end, I will find other ones to join."*

Citizen science participants tended to sign up for projects that aligned with their general interests. For example, one woman signed up for projects counting dragonflies and hummingbirds, *"I was inspired to sign up because of my basic interest in nature and gardening. For the hummingbird project, I already had some plants in my yard to attract hummingbirds. I record observations about bird type, plant or nectar. Before watching the show, I didn't know that there was something that I was already doing that I could contribute."*

A retiree living in New York signed up for a project recording decibel levels of sounds around the city: *"The show got me involved. Rather than sitting on the sidelines and commenting, 'Oh, that's good. That's bad,' I can participate. If it wasn't for the documentary, I wouldn't be involved."* He attributed his interest in sound levels to his background growing up in a small town in Canada, moving to Montreal, and eventually New York City. He explained that the ambient sounds in these varied environments are completely different, and that people get accustomed to the noise.

An interviewee who spends his time traveling the country in an RV was drawn to the CoCoRaHs and Open Street Map projects: *"Mapping and CoCoRaHs caught my attention. There are so many places I go, that unless you are a local you wouldn't go there. There aren't many people there. Ghost towns and places out west - none of that stuff is marked."* He elaborated, *"I like to travel, so it makes it difficult for me to be involved in some types of projects. I am figuring out how I can be involved from anywhere. I can put up a weather station anywhere that I am for more than 24 hours."*

Watching The Crowd & The Cloud inspired two viewers to incorporate citizen science and crowdsourcing into projects in which they were already involved. For example, one viewer was struck by the Open Street Map segment and thought that the street level detailing of satellite imagery could be used for an existing effort to find Holocaust mass graves in Eastern Europe. After viewing an episode, he wanted to include citizen scientists in his project. Similarly, a woman who saw a tweet about the series watched Episode One, *"and was so impressed. It is a program that changes how people think and act."* She shared that the series *"accelerated the development of my project,"* which uses a mobile app to identify the locations of defibrillators used for those in cardiac arrest. She connected with the series' producers and Mosquito Alert, a featured project in Episode Three, and was able to use their

interface to design an app prototype: *"Had I not got that tweet about The Crowd & The Cloud, we would not have embarked on building this independently. By doing the right homework and finding the right people, we have been able to build and test something much sooner."*

The examples above are powerful illustrations of the impact of the series on a variety of participants. The Crowd & The Cloud not only introduced people to the concept of citizen science, but also helped them connect some of their own interests to citizen science initiatives. For some, the series gave them ideas for ways to apply data collection or dissemination methodologies to problems they were already working on addressing.

Summary of Impacts of the Broadcast Series on Specific Audiences

Members of the general public who viewed an episode of the series gained more familiarity with and greater understanding of citizen science, expressed interest in related topics, and greater confidence in their ability to participate in citizen science. They were also more likely to engage in citizen science-related activities than those who did not watch the series, which suggests that members of the general public were starting to move from passive viewers to being more actively engaged in citizen science. Although those who viewed an episode were more likely to believe that anyone can do citizen science and that data collected by citizens is valid, they also indicated some trepidation. Specifically, those who viewed an episode thought that collecting scientific data can be challenging and that analyzing data should be left to professional scientists. Regardless, those who watched an episode were significantly more likely to feel confident in and indicate a likelihood to participate in citizen science projects in the future.

Although some professional scientists were already familiar with citizen science and crowdsourcing (54% of focus group participants), those who watched an episode still gained a greater understanding of the nuances of these concepts than those who had not viewed the series. Yet, scientists had mixed reactions about citizen science and the participation of the general public in scientific research. Those who watched an episode of the series welcomed citizens as data collectors, leveraging people who are interested in contributing to scientific research in order to gather larger amounts of data efficiently. But many believed that scientists should analyze that data. Furthermore, scientists were divided on the issue of the validity of data collected by citizen scientists. Some felt that data collected by citizens can be just as valid as data collected by professional scientists, while others did not trust everyday citizens to be fully reliable without professional oversight. Viewing the episodes did not really impact scientists' participation in citizen science-related activities, with the exception that scientists who watched an episode were more likely to post about citizen science on social media than those who had not. This finding suggests a willingness on the part of professional scientists to share information about the citizen science movement with others.

For the most part, the impacts of the series on citizen science participants were relatively small. This group was already highly confident in and engaged with citizen science activities. They also already had positive beliefs about citizen science, and were familiar with citizen science and crowdsourcing as concepts. However, those who viewed an episode gained a significantly better understanding of the relationship between crowdsourcing and citizen science, as well as more knowledge of how citizen science findings are used by others, compared to those who did not view the series. Citizen scientists who viewed an episode appreciated the focus on the different technologies that can be employed to aid citizen science efforts, and appreciated that the episodes showcased citizen science initiatives that were realistic, relevant, and fun.

The Crowd & The Cloud Website's Users

Website Traffic

Between March 1, 2017 to June 30, 2017, there were over 33,000 website sessions (visits) and over 21,000 users on The Crowd & The Cloud's website. Major spikes in website traffic were associated with the four major episode air dates (April 6th, 13th, 20th, and 27th), as illustrated by Figure 15 below. Survey respondents confirmed that the main way that they found out about the website was by watching an episode of the series on television (see Table 11). Most segments within the episodes presented an on-screen URL, corresponding to content specifically related to that sequence (e.g., CrowdAndCloud.org/Alzheimers).

Approximately half of all website sessions during the March through June time period came from users typing in the main website url (48%), while a third (32%) of the visits came through using search engines, such as Google. Only a small portion of visits came from referrals from other websites (7%) or social media (11%).

Although referrals from other websites were a relatively small source of traffic, the website that referred the most users to The Crowd & The Cloud over the four month period is a well-established climate science and environmental activist blog, grist.org (see Table 37, Appendix D for list of top ten website referrals). Interestingly, the top two referral websites featured stories about The Crowd & The Cloud, while two other websites in the top ten (World Bank and Bright Focus) were projects featured in the series.

Figure 15. The Crowd & The Cloud Website Traffic (March - June 2017)

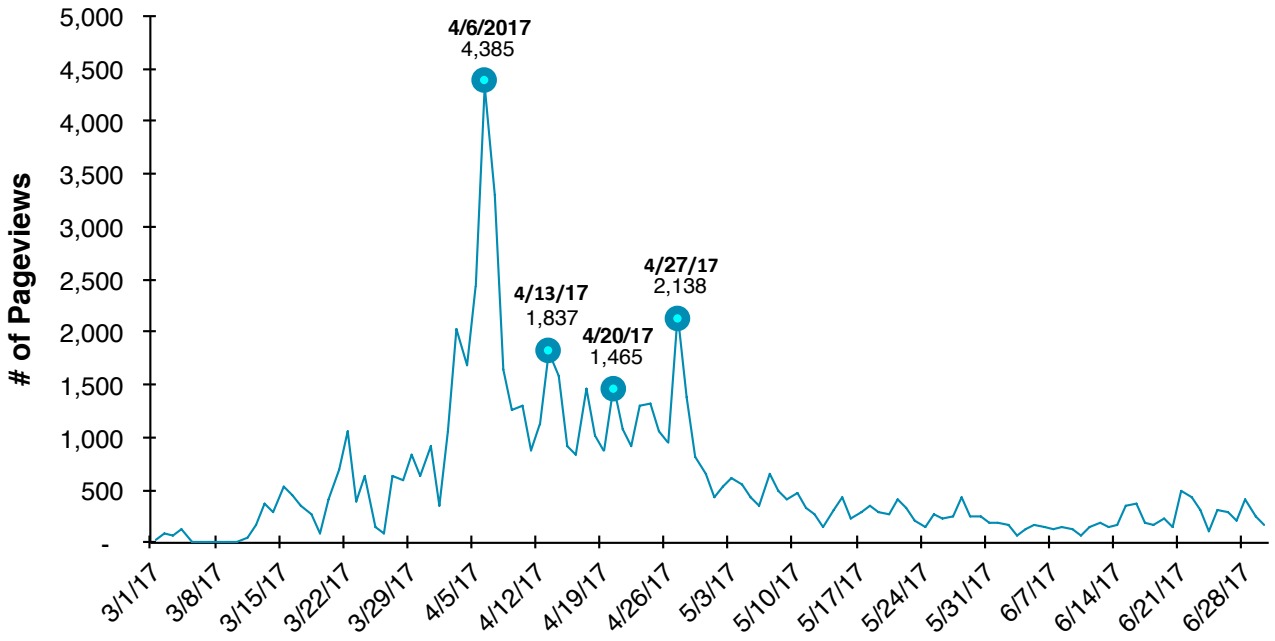


Table 11. How Survey Respondents Learned About The Crowd & The Cloud Website (N=300)

Method	# of Survey Respondents
Watched The Crowd & The Cloud on television	138
SciStarter.com	55
Email from an organization	48
Family member/friend/colleague	43
Google/search engine	34
Another website*	29
My job	22
Social media*	21
Other*	20

** Other responses included: CoCoRaHS (4), Television (1), Episode preview (1), Public television email (4), Survey invite (7), focus group (3), Google (2), OLC Conference (1). Specific websites mentioned included: CoCoRaHS (23), public television websites (4), and scienceathome.org (1). Specific social media mentioned included: Facebook (12), Twitter (4), CIRES (3), and @Witnesses_BOS (1). Specific organizations mentioned included: Local PBS station (28), CoCoRaHS (4), CIRES (3),CitSci listserv (2), MD Master Naturalists (1), ASME (1), Boulder Flycasters TU (1), and ScienceAtHome (1).*

Facebook accounted for most of the social media traffic to the website (approximately 73%), while Twitter accounted for approximately 18%. Although the project team did not maintain social media accounts on Reddit, Google+, or LinkedIn, arrivals from these three aggregate sources accounted for approximately 0.5% of website sessions across the four months of the study. There were almost no referrals from Instagram (0.3% of all website sessions; 11 new users referred to the website over the four months). One reason for Instagram's low referral rate may be that the Instagram community has less opportunities to see or follow website links. The platform only allows users to post hyperlinks in their profile pages. Hyperlinks do not work within Instagram post comments, and the feed of image-oriented posts tends to dominate the user experience.

During May and June, the two months following the major television broadcast dates, social media accounted for approximately 6.4% of website sessions (370 new users out of 5,209 new users to the website in total during May and June), showing the minor supplemental impact that social media afforded after the major television broadcast dates. After the major television broadcast dates, Facebook was the top source of social media traffic to the website, accounting for approximately 80% of website sessions originating from social media in May and June, and 5% of all website sessions, (474 sessions from Facebook out of 9,392 sessions overall during May and June).

Reasons For Visiting The Crowd & The Cloud Website

Users identified a variety of reasons for going to The Crowd & The Cloud's website. Survey respondents tended to visit because they are interested in the topic of citizen science or because they enjoy science websites, in general (see Table 12). Online focus group participants identified three main reasons for why they visited The Crowd & The Cloud website: 1) To watch or rewatch episodes, 2) to find out more information about the series or citizen science, and 3) to get involved in a project. Participants elaborated that the website was the next logical step to learn more about citizen science after viewing an episode. One focus group member explained, *"Going on the website gives you the tools to engage with citizen science."*

Table 12. Reasons Survey Respondents Visited The Crowd & The Cloud Website (N=297)*

Reason	# of Survey Respondents
I enjoy science websites	138
I am interested in the topic of citizen science	55
I was looking for information about The Crowd & The Cloud series	48
I was looking for information on citizen science	43
My friend/family member recommended it	34
I was looking for information on specific projects featured on The Crowd & The Cloud	29
I was looking for ways to participate in citizen science	22
Other**	20

** Some respondents provided more than one reason.*
*** Other responses included: General curiosity (4), CoCoRaHS (3), related to job (3), topic of interest to family (2), focus group (2), email invite (3), watched the show online (2), Twitter search (1), my organization was featured (1), and public television station email (1)*

What Users Did on The Crowd & The Cloud Website

Users first oriented themselves to the website, starting with the homepage, followed by watching Episode 1 of the series (see Table 13). The third most popular page was the "Join a Project," and the sixth most popular page was the "Citizen Science Calendar," suggesting that after being oriented to the website, new users were interested in getting more involved with doing citizen science. Users also spent the most time, on average, exploring the "Join a Project" page, suggesting deeper engagement with that page's content. The "About the Series" page along with the other episodes and their air dates, were also popular, indicating that users wanted to watch more of the series and/or gather more information about it. It should also be noted that the popularity of a video segment on Alzheimers suggests a topic that particularly resonated with website users.

The typical user pathway through the website, illustrated in Figure 16, shows that in most cases, users entered the site through the homepage and then proceeded to the first episode, or went directly to "Join a Project." Users also often visited the "About the Series" page after the homepage, and in many cases visited the "Citizen Science Calendar" page directly after the homepage. After watching the first episode, many users continued to watch Episode Two or visited the "About the Series" page. Users who went to the "About the Series" page

entering on the homepage, then went to watch Episode One or to “Join a Project.” In sum, users seemed to engage with multiple aspects of the website during a single session.

Table 13. Top Ten Web Pages Visited By The Crowd & The Cloud Website Users

Method	Total Page Views	Average Time Spent on Web Pages
Homepage	23,306	0:01:24
Episode 1	12,093	0:02:38
Join a Project	8,920	0:08:19
About the Series	8,498	0:02:50
Episode 2	2,982	0:02:21
Citizen Science Calendar	2,759	0:03:06
Episode 4	2,463	0:03:31
Episode 3	1,934	0:02:52
Episode 1 Air Dates	540	0:05:43
Alzheimers Video	478	0:03:40

These results mirror online focus group participants’ indication of their favorite pages on the website. They liked the Citizen Science Calendar, Join a Project, and pages about or for the episodes the most. These participants stated that they had wanted more information about the organizations featured in the episodes, to know when the other episodes were airing, or were looking for ways that they could become involved.

Another way focus group participants engaged with The Crowd & The Cloud website was through the newsletter. In particular, those who do not use social media enjoyed receiving these newsletter updates. Similarly, some participants who do not use social media appreciated the social media content provided by the sidebar on The Crowd & The Cloud website itself. One participant explained, *“Now that the social media feed is on the webpage, you can find all the social media posts right on the site, anything that gets posted on the site is right there.”* This participant and others in the focus groups indicated that this feature allowed them to view the social media content without having to sign up for or follow The Crowd & The Cloud on other social media platforms.

Some focus group members used the website, while they were watching an episode of the series on television or online. These members enjoyed being able to look information up in real time: *"I found The Crowd & The Cloud on YouTube. I thought it was intriguing, and decided to watch. When I saw something I liked, I then looked it up on the website on my phone."* During WORLD Channel broadcasts, live tweets with content relevant to each segment of an episode appeared on Twitter. After broadcast, these tweets appeared beside the relevant videos of episodes on The Crowd & The Cloud's website. Thus, in some instances, The Crowd & The Cloud website extended the series' viewing experience.

Figure 16. The Crowd & The Cloud Website User Paths Across All Sessions (March - June 2017)

Impacts of The Crowd & The Cloud Website on Users

Awareness and Understanding of Citizen Science and Crowdsourcing

The Crowd & The Cloud website was designed to support and enhance the broadcast series. However, one of the questions this evaluation sought to explore was the impact of specific media elements on users. To that end, unmatched survey responses (i.e., responses from individuals who did not use the website were compared to responses from different individuals who did use the website) were compared to examine whether those who used the website had a different awareness or understanding of citizen science and crowdsourcing. To mitigate the effects that viewing an episode of the series might have, only individuals who had not viewed an episode of The Crowd & The Cloud were included in the sample. Due to the small sample size of website users, the data was not broken down by specific audience (i.e., general public, professional scientists, and citizen science participants).

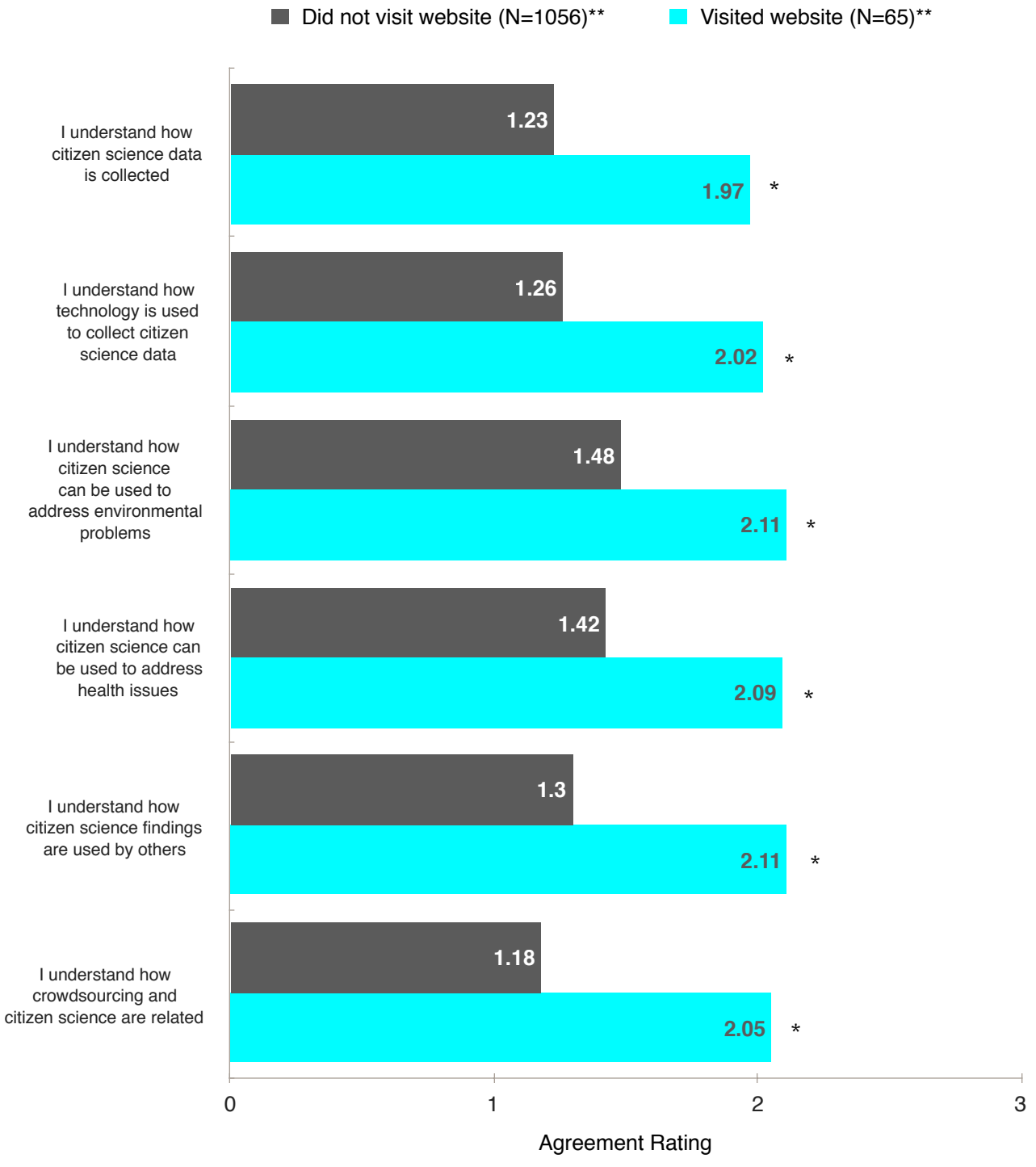
Survey respondents who had visited the website were significantly more familiar with the term, "citizen science," than those who had not been to the website (see Table 14). Website users were also significantly more likely to agree that they understood various aspects of citizen science than those who had not been to the website (see Figure 17). One respondent who used the website shared that he had learned, *"How powerful the cloud and our interconnectedness (via technology and social media) is."* There were no significant differences between those who had used the website and those who had not in terms of their self-reported familiarity with crowdsourcing. However, overall, it appears that website users had a better understanding of and familiarity with citizen science concepts.

Table 14. Unmatched Survey Respondents' Familiarity with Citizen Science Based on Whether or Not They Visited The Crowd & The Cloud Website

Type of Respondent	Total N	Mean**	Significance
Did not visit website	1222***	1.75	.000*
Visited website	70	2.83	

** Indicates a significant difference at the p < .05 level*
*** On a scale from 0 to 5, with 0 being "Not at all familiar" and 5 being "Very Familiar"*
**** This number represents useful baseline data regarding individuals' awareness, understanding, beliefs, and behaviors around citizen science*

Figure 17. Unmatched Survey Respondents' Understanding of Citizen Science Based on Whether or Not They Visited The Crowd & The Cloud Website



** Indicates a significant difference at the p < .05 level*

*** On a scale from 0 to 3, with 0 being "Strongly Disagree and 3 being "Strongly Agree"*

After visiting the website, survey respondents were asked what they found out from the website and the main messages they took away after exploring its contents. Their responses were thematically coded to determine whether website users had any shared takeaways. Several respondents (16%, N=142) indicated that they found out that citizen science is more widespread than they had previously thought, and encompasses a range of project types:

> *There are projects to suit anybody globally. I was so excited to see so many great projects and opportunities for participation. We do matter and can make a difference in the world.*
>
> *There are many more projects than expected that you can participate in in my area… There are multiple ways to participate.*
>
> *There are many more applications for citizen scientists than I ever imagined. Large projects can be tackled by groups of involved citizens.*
>
> *I really like seeing the profiles of the different scientists featured. Science is and should be diverse! There are so many opportunities to practice citizen science.*

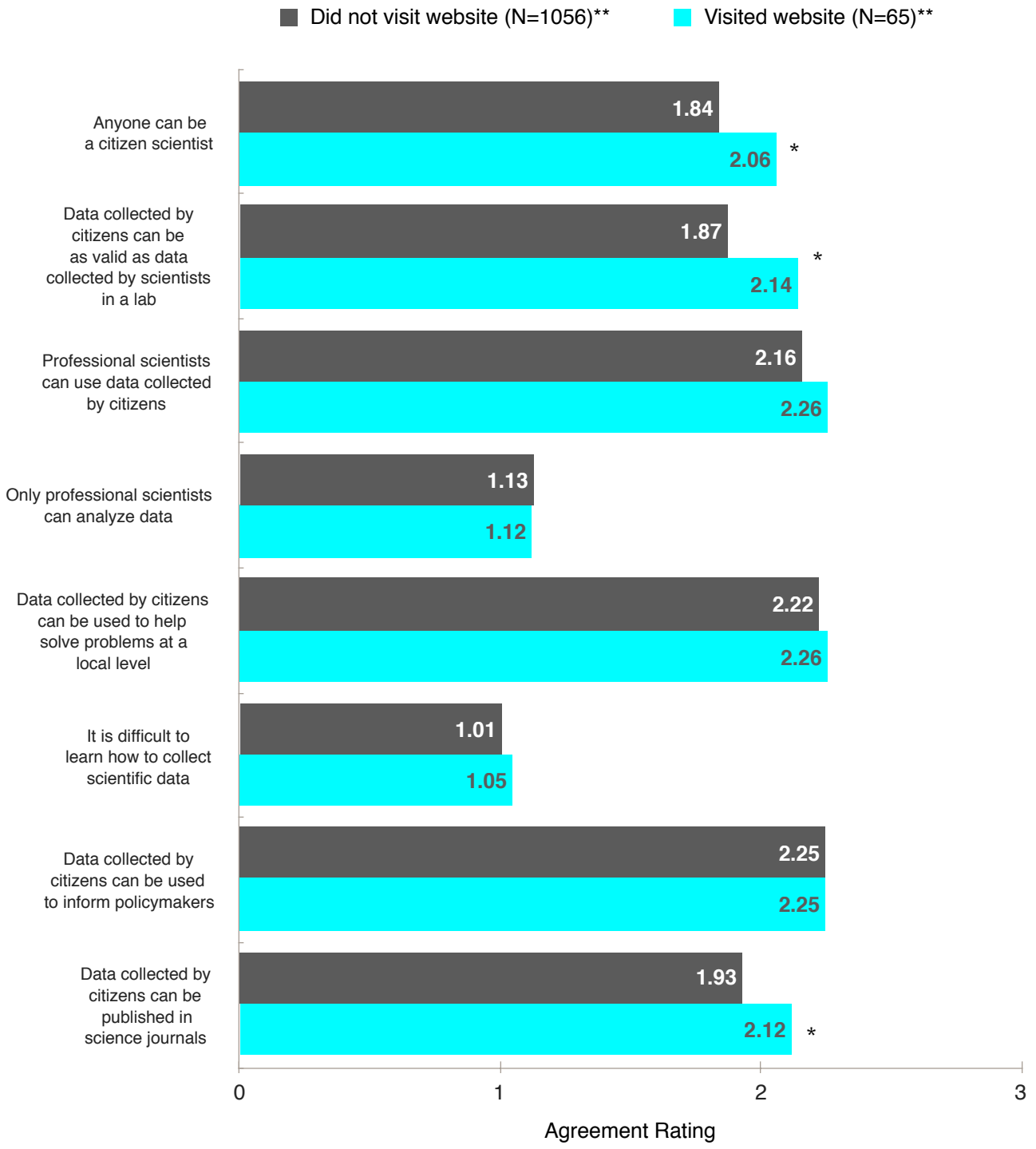
Attitudes Towards Citizen Science

Beliefs About Citizen Science

Survey respondents who had visited the website were significantly more likely to agree that "Anyone can be a citizen scientist" than those who had not visited the website (see Figure 18). When asked about the main messages they gleaned from the website, survey respondents mentioned that they had learned that ordinary people can contribute to citizen science:

> *The importance of anyone's contribution to science, no matter how small or how great. It is all important.*
>
> *I, as an individual, as a teacher, as a mentor can impact on our knowledge base, and contribute in a meaningful way to research.*
>
> *As Chairman of the Board of our local Senior Center, citizen science is a natural for retired people who still want to contribute to their community. This could be as beneficial to them as to the projects.*
>
> *Just like the show, [the website] shows how anyone can make a difference and learn more about many different topics that can impact the environment.*

Figure 18. Unmatched Survey Respondents' Beliefs About Citizen Science Based on Whether or Not They Visited The Crowd & The Cloud Website



** Indicates a significant difference at the p < .05 level*

*** On a scale from 0 to 3, with 0 being "Strongly Disagree and 3 being "Strongly Agree"*

It reminded me of something the Dalai Lama once said, 'If you think you're too small to make a difference, try sleeping with a mosquito.' We all can have an impact.

Website users were also significantly more likely to agree that data collected by citizens "can be as valid as data collected by scientists in a lab" and that it can be "published in scientific journals." Respondents brought up the validity and usefulness of citizen science data in their open-ended survey responses:

The data gathered by citizen scientists throughout history are currently being used today. In areas such as climate change, their data can be used as a benchmark against data currently being gathered.

The importance of more granular and consistent data to make better observations and to increase our understanding.

Thus, website users believed the message that ordinary citizens can engage in citizen science, and that the scientific practices they engage in are valid and valuable to the scientific community.

Although there were no significant differences between website users and non-users in terms of their belief that data collected by citizens can be used to help solve community problems (both tended to agree with this statement), website users noted the importance of citizens addressing relevant issues in their open-ended survey responses:

I'm not alone. People all over the United States, indeed all over the world are interested in citizen science. You can't count on government for a timely response. We, as citizens, need to step up to the plate.

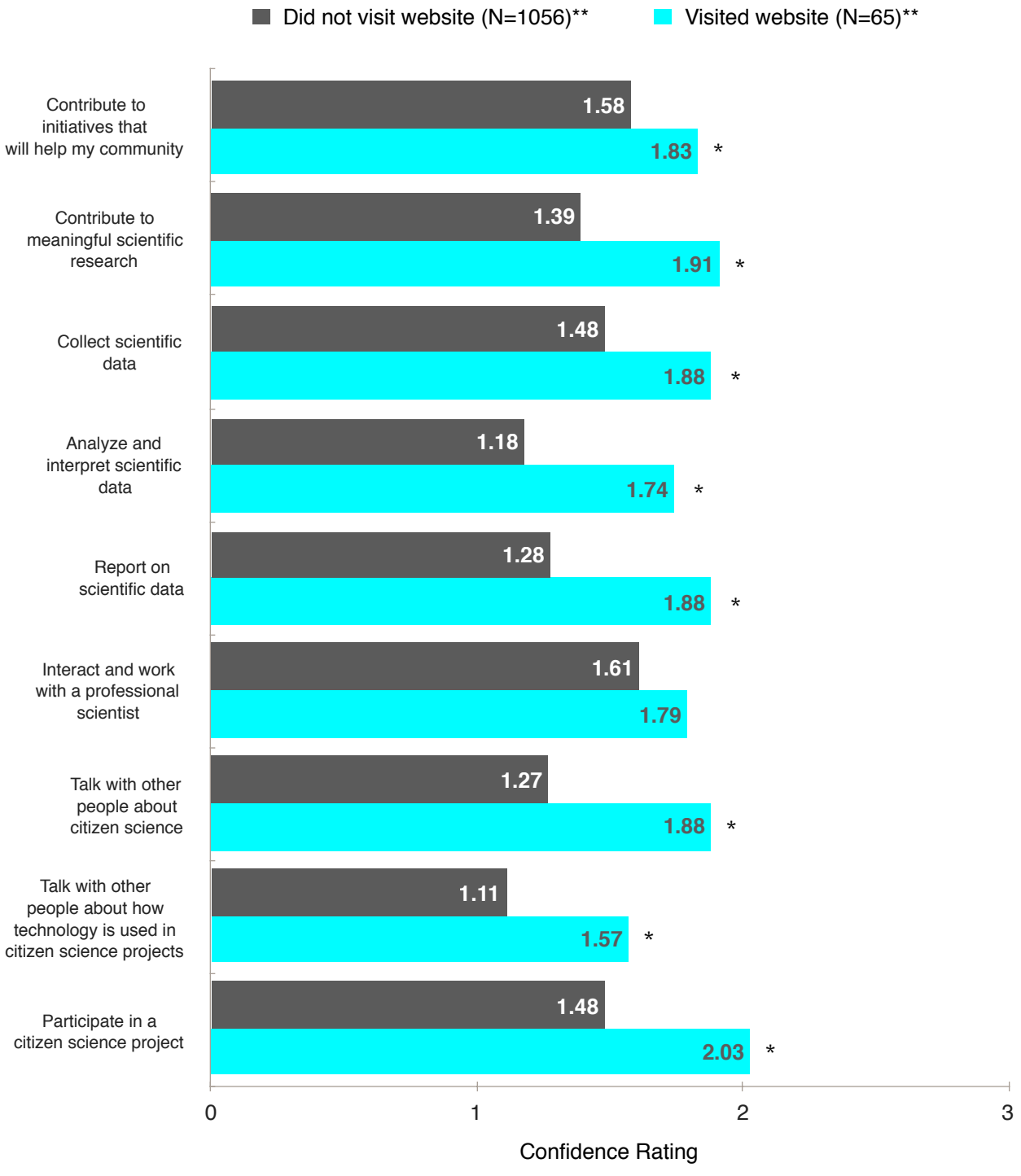
I found out about the harmful effects of dangerous chemicals in water in certain cities and how fracking devastated a family in their peaceful habitat. Also how ordinary citizens can advocate for themselves.

The results [of citizen science] are improving health and welfare, assisting in wildlife conservation, and giving communities the power to create needed change and help themselves. That says it all.

Confidence in Citizen Science Abilities

Survey respondents who had visited the website were significantly more likely to feel confident in their ability to contribute to initiatives that would help their communities and to meaningful scientific research than those who had not visited the website (see Figure 19).

Figure 19. Unmatched Survey Respondents' Confidence in Their Citizen Science Abilities Based on Whether or Not They Visited The Crowd & The Cloud Website



**Indicates a significant difference at the p < .05 level*

***On a scale from 0 to 3, with 0 being "Not at all confident" and 3 being "Very confident"*

Website users were also significantly more confident in their ability to engage in scientific practices like collecting, analyzing, and reporting on scientific data. Furthermore, they felt significantly more confident in their ability to participate in citizen science projects, as well as talk about citizen science and how technology is used in citizen science with others. Taken together, these findings suggest that website users were not only convinced that anyone can do citizen science, they were confident that they themselves could engage in citizen science-related activities, a step that supports one of the main project goals of turning viewers into doers.

Interest in Related Topics

Online focus group members were in agreement that visiting the website increased their interest in watching the other episodes of the series. This desire seems to be supported by the previously described online analytics, which showed that several users went on to watch subsequent episodes online after viewing Episode One (see Figure 16).

Table 15. Survey Respondents' Interest in Science-Related Topics After Visiting The Crowd & The Cloud Website

Topic	Total Respondents*	% of Respondents Reported "Increased Interest"
Citizen science	239	69%
How technology is used in citizen science	242	68%
Environmental topics	241	65%
Natural disaster response planning	240	64%
Scientific research in health and medicine	241	63%
Geographic science	242	62%
Talk with other people about citizen science	240	59%

** The total number of respondents here represents both those who only used the website, and those who used the website and viewed an episode of the series*

In addition, users indicated that exploring the website had positively impacted their interest in a variety of topics (see Table 15). Survey respondents were asked whether the website increased or decreased their interest in specific topics on a scale from 0 to 4, with 0 being "Decreased a lot" and 4 being "Increased a lot." The percentage of respondents who answered "Increased a little" or "Increased a lot" can be found in Table 15 above. The largest

percentage of website users felt that their interest in citizen science, in general, and how technology is used in citizen science specifically had increased, although the majority of respondents indicated positive increases across all topics.

Participation in Citizen Science-Related Activities

Survey respondents who used the website were significantly more likely to engage in citizen science-related activities than those who did not use the website (see Figure 20). However, when asked what activities they did since visiting the website, the largest number of survey respondents said that they had talked with friends or family about citizen science initiatives (see Table 16). Online focus group participants also saw the website itself as a valuable resource to share with their friends and family.

> **"I know people who want to be involved in citizen science. [It's] very easy to send someone the link and tell them, 'Go to this website. Everything you need is there.'"**
>
> **- Website User**

One participant explained, *"If you want to tell other people about the show and projects, you can refer them to the website."* Another focus group member added, *"I know people who want to be involved in citizen science. [It's] very easy to send someone the link and tell them, 'Go to this website. Everything you need is there.'"* Multiple focus group participants in education fields, including professors, K-12 teachers, homeschool parents, and babysitters, were eager to share the resources of the website with their students.

> **"Science is not only something you can learn about, but something you can do."**
>
> **- Website User**

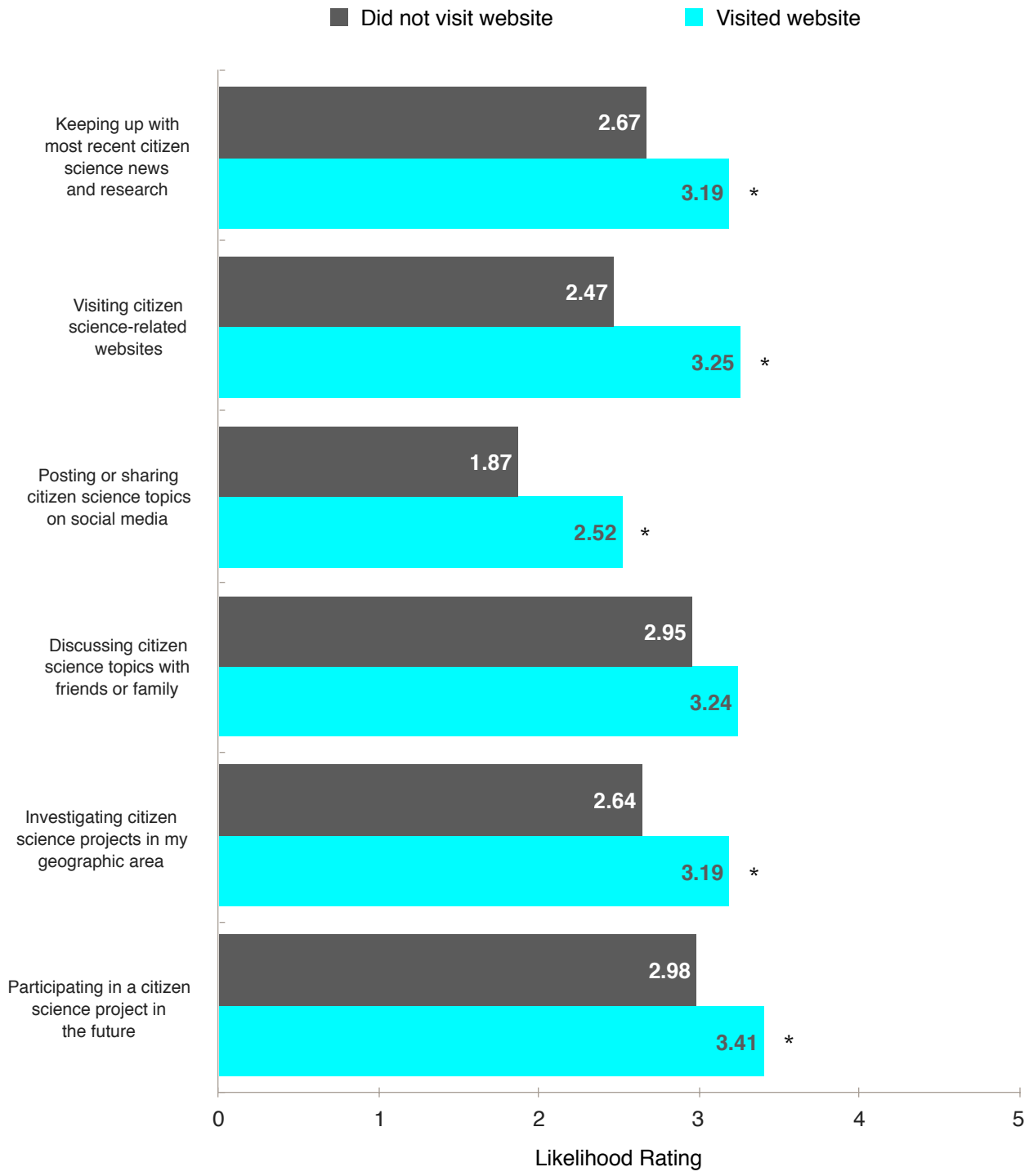
The website was also effective in inspiring users to participate in citizen science (see Table 16). Website focus group participants liked that the website invited people of all ages to participate and search for projects of interest to them:

Science is not only something you can learn about, but something you can do.

This is an awesome site that can connect someone at any stage in life to citizen science.

I like that you can find projects in a specific location for a certain age and topic. This is great for connecting science to a real world application.

Figure 20. Unmatched Survey Respondents' Likelihood of Participating in Citizen Science-Related Activities Based on Whether or Not They Visited The Crowd & The Cloud Website



** Indicates a significant difference at the p < .05 level*

*** On a scale from 0 to 5, with 0 being "Not at all likely" and 5 being "Very likely"*

Table 16. Survey Respondents' Follow-Up Activities After Visiting The Crowd & The Cloud Website*

Activity	# of Respondents (N=70)
Talked with friends or family about citizen science initiatives	27
Visited website for an organization featured on The Crowd & The Cloud	19
None of the above	18
Searched for more information on citizen science projects	17
Checked out The Crowd & The Cloud on social media	16
Signed up for The Crowd & The Cloud newsletter	14
Searched for a citizen science project to get involved in	9
Increased or renewed your involvement in a citizen science project you've participated in before	9
Visited SciStarter.com	8
Talked to a citizen scientist	5
Engaged with The Crowd & The Cloud or citizen science in another way	5
Signed up for a citizen science project	3

**Some respondents listed more than one activity*

Online focus group participants indicated a desire to return to the website to view new content, particularly around new opportunities to get involved in projects in their areas of interest. A focus group member explained, *"For me, I liked the way on the website you could look up projects or activities to get involved in based on your interest, age, etc."* Furthermore, as already described in Table 13, "Join a Project" and the "Citizen Science Calendar" were among the top ten most utilized pages of the website, which suggests an interest from website users to get more involved in citizen science initiatives.

Three out of seventeen online focus group participants indicated that they had signed up for citizen science projects directly from The Crowd & The Cloud website. One joined a project to track hummingbirds and dragonflies. Another signed up for a project on bees with her niece, and the third participant joined CoCoRaHs, the weather-tracking initiative featured in Episode One of the series. One focus group member felt that the website was a crucial tool in getting him involved in citizen science, *"There is no way I can see myself joining a project without the website."*

Survey respondents who visited The Crowd & The Cloud website were also asked whether they had been to SciStarter, a searchable online database of citizen science projects individuals can join. Nearly half of the website users who took the survey (41%, N=239[7]) indicated that they had been to the SciStarter website. Of these, the largest percentage indicated that they had visited SciStarter in order to learn more about citizen science or to join a project (see Table 17). In fact, over half of those who responded (52%, N=95) indicated that they had joined a project on SciStarter. Of those who hadn't visited the SciStarter website, 72% (N=234) indicated that they planned to do so in the future.

Table 17. Information Survey Respondents Sought on the SciStarter Website*

Purpose for Visiting SciStarter	% of Respondents (N=94)
Learn more about citizen science	66%
Join a project	53%
Connect with a project leader	33%
Learn about upcoming citizen science events	24%
Other	11%

** Some respondents listed more than one reason for visiting SciStarter website*

A separate analysis of referrals from The Crowd & The Cloud website to SciStarter showed that from April to June 2017, 4,487 users went to SciStarter, following their visit to The Crowd & The Cloud website. Referrals from The Crowd & The Cloud website to SciStarter were strongest in April (approximately 2.7k referrals), with declining activity in May and June (approximately 1k referrals each).

Once at the SciStarter website, 282 users signed up for a citizen science project, indicating their desire to engage more deeply with citizen science. Referrals to SciStarter indicate that Alzheimer's research-related citizen science projects were most appealing to users who came to SciStarter from The Crowd & The Cloud website and who also signed up for a citizen science project. EyesOnALZ was the most popular project, with 27 "joins" and 37,985 "contributions" on SciStarter during the four-month study period (see Table 38, Appendix D for top ten projects joined during the study period). This is consistent with the previously

[7] This number reflects both those who only visited the website, and those who used the website and watched an episode of the series.

mentioned website analytics, which revealed that content related to Alzheimer's research was the most viewed topic among website users (see Table 13).

In sum, The Crowd & The Cloud website plays an important role in encouraging users to learn about and join citizen science projects. Viewers of the series went to the website to learn more information about the show, watch additional episodes, and discover ways that they can become involved in citizen science activities.

Value Added From the Website

The question of what value The Crowd & The Cloud website added to the user experience beyond the broadcast series can be addressed by comparing unmatched survey responses from individuals who only viewed the broadcast with those who only used the website, and those who both viewed the broadcast and used the website. This analysis examined both the cumulative impact of the broadcast and digital media, as well as whether the website was more effective than the series in addressing particular outcomes. As before, the analysis was not broken down by specific audiences.

"There is no way I can see myself joining a project without the website."

- Website User

In terms of familiarity with and understanding of citizen science, those who both watched an episode of the series and used the website experienced greater impacts than those who only saw the content in one medium. Specifically, those who both watched an episode of the series and used the website were significantly more familiar with the term, "citizen science," than those who only viewed an episode, $t(323)= -3.046$, $p=.003$. Similarly, those who both watched an episode of the series and used the website were significantly more familiar with the term, "citizen science," than those who only used the website, $t(291)= -3.003$, $p=.003$. Those who utilized both the broadcast and digital media were also significantly more familiar with the term, "crowdsourcing," than those who only viewed an episode, $t(313)= -2.101$, $p=.036$. In addition, respondents who watched an episode and used the website reported having a significantly greater understanding of how citizen science data is collected, $t(269)= -2.791$, $p=.006$, and how citizen science can be used to address environmental problems, $t(269)= -3.456$, $p=.001$.

When examining survey respondents' confidence around citizen science after using various media, a few differences emerged. For example, those who both watched an episode and used the website felt significantly more confident that they could contribute to initiatives to help their community than those who only viewed an episode, $t(269)= -3.057$, $p=.002$. They also felt significantly more confident in interacting with and working with a professional

scientist, t(269)= -3.548, p=.000, contributing to meaningful scientific research, t(269)= -4.681, p=.000, and analyzing and interpreting data, t(269)= -2.826, p=.005. In addition, those who both watched an episode and used the website felt significantly more confident in talking to other people about how technology is used in citizen science projects than those who only used the website, t(245)= -2.024, p=.044.

Interestingly, there were also some differences between those who only used the website versus those who only watched an episode in terms of confidence and beliefs. Here, those who only used the website were significantly more confident in their ability to contribute to meaningful scientific research than those who only watched an episode, t(152)= 2.525, p=. 013. They were also significantly more confident in their ability to analyze and interpret scientific data, t(152)= 2.046, p=.042.

Those who used both the broadcast and digital media also expressed some differing beliefs about citizen science than those who had only viewed an episode of the series. Specifically, those who watched an episode and used the website agreed more strongly that anyone can be a citizen scientist, t(269)= -3.931, p=.000. They also were significantly more likely to agree that professional scientists can use data collected by citizens, t(269)= -2.005, p=.046. In addition, those who both watched an episode and used the website were significantly more likely to think that it is difficult to learn how to collect scientific data, t(269)= -2.499, p=.013.

The combination of broadcast and digital media also led to increases in participation in citizen science, compared to the series alone. For example, those who watched an episode and used the website were significantly more likely to visit citizen science websites, t(266)= -5.763, p=.000, and post or share citizen science topics on social media, t(266)=-4.161, p=. 000, than those who only watched an episode of the series. Those who watched an episode and used the website were also significantly more likely to discuss citizen science topics with friends and family, t(266)= -3.190, p= .002. In addition, respondents who watched an episode and used the website were significantly more likely than those who only viewed an episode to investigate citizen science projects in their local area, t(266)= -3.217, p=.001, and be willing to participate in citizen science projects in the future, t(266)= -2.171, p=.031.

Interestingly, there were also some differences between those who only used the website versus those who only watched an episode in terms of confidence, beliefs, and participation. Here, those who only used the website were significantly more confident in their ability to contribute to meaningful scientific research than those who only watched an episode, t(152)= 2.525, p=.013. They were also significantly more confident in their ability to analyze and interpret scientific data, t(152)= 2.046, p=.042. In addition, those who only used the website were significantly more likely to agree that anyone can be a scientist than those who only viewed an episode, t(152)= 2.750, p=.007. Finally, those who only used the website were

significantly more likely to indicate that they would visit citizen science websites, t(149)= 4.258, p=.000, investigate citizen science projects in their area, t(149)= 2.120, p=.036, and participate in a citizen science project in the future, t(149)= 2.481, p=.014, than those who only watched an episode.

Taken together, these findings suggest that the website added value to the series in terms of supporting participants' familiarity with and understanding of citizen science, attitudes and confidence around citizen science, and participation in citizen science activities. Furthermore, the website by itself elicited greater impacts in some areas than the series alone.

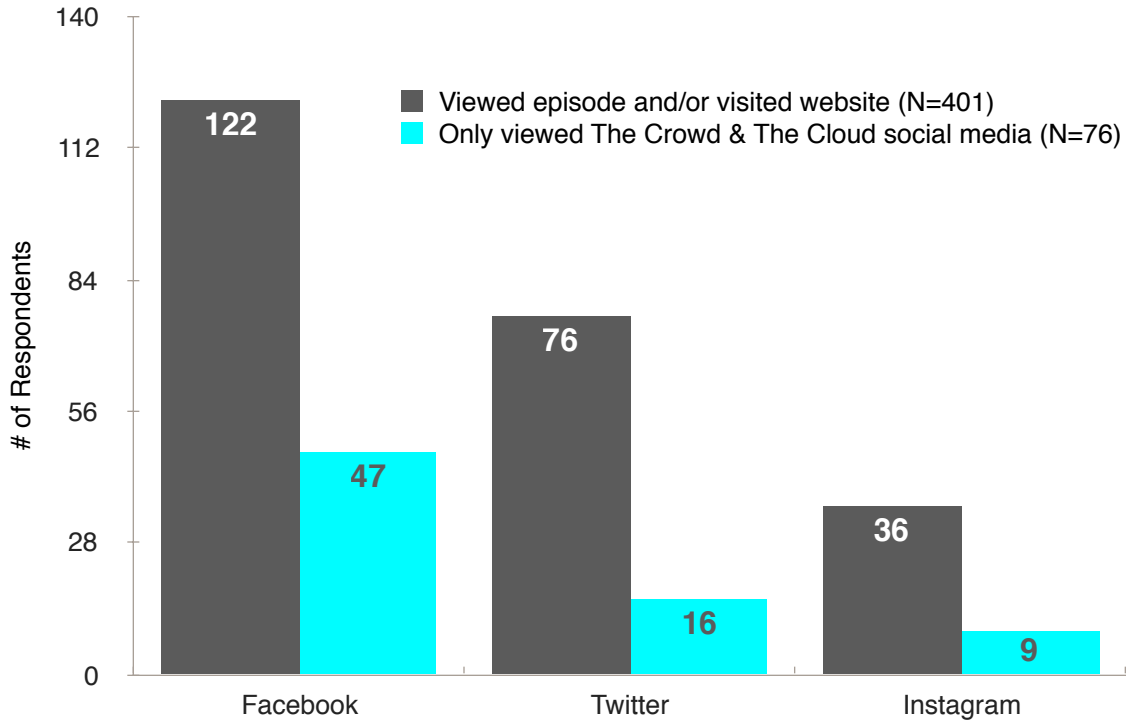
The Crowd & The Cloud Social Media Users

Social Media Traffic

Survey respondents (N=401) who viewed an episode of The Crowd & The Cloud and/or had visited the website, as well as survey respondents who had not done so (N=76), indicated that they visited several of The Crowd & The Cloud's social media platforms (see Figure 21). The largest number of respondents in both groups reported visiting The Crowd & the Cloud's Facebook page. Focus group members (8 out of 17) confirmed that Facebook was their preferred way of engaging with The Crowd & The Cloud on social media as well. Four focus group members had followed The Crowd & The Cloud's Twitter account, and only one focus group member had previously used The Crowd & The Cloud's Instagram page. Five focus group members had not utilized The Crowd & The Cloud's social media at all.

The survey and focus group results above track with social media analytics collected from March to April 2017. Here, social media traffic was measured by the number of new followers on The Crowd & The Cloud's social media platforms, as well as the extent of follower engagement (i.e., the number of interactions people have with the content through liking or sharing a post). Over a four month period and across the three social platforms included in this analysis, the social media audience grew by approximately 2,739 followers, with 1,247 new followers joining in May and June after the major television broadcast air dates. On average, each social media posts was displayed to 936 people across the three social media platforms.

Figure 21. Number of Respondents Who Visited The Crowd & The Cloud's Social Media Platforms*



Some respondents visited more than one social media platform

Facebook posts received the most impressions per post, as compared to Twitter and Instagram, particularly in April (see Table 18). An impression is the count of the number of times content was displayed. Even with fewer Facebook posts each month, The Crowd & The Cloud's Facebook posts received more impressions per post than Twitter (see Figures 22 & 23). However, The Crowd & The Cloud's Twitter had more new followers, on average, than Facebook or Instagram. Yet Twitter followers tended not to stick around - there were 343 unfollows from March to June. However, there were only 39 users who removed themselves from The Crowd & The Cloud's Facebook page. This trend suggests that Twitter got slightly more people exposed to citizen science concepts and projects than other social media platforms, but that as momentum for the project grew, more individuals visited and continued to follow the content via Facebook.

Table 18. Size of The Crowd & The Cloud's Audience on Various Social Media Platforms

Time Period	Average Impressions Per Post**				New Followers or Fans*			
	Twitter	Facebook	Instagram	Across all Social Media	Twitter	Facebook	Instagram	Across all Social Media
Overall	405	1,324	1,078	**936**	1,319	1,029	391	**2,739**
March	739	177	918	**611**	87	94	327	**508**
April	382	2,938	1,111	**1477**	261	667	54	**982**
May	328	608	1,137	**691**	928	154	1	**1,083**
June	410	681	1,149	**747**	43	114	7	**164**

** Facebook Fans are people who have liked or followed the Facebook page. The total number of Twitter followers reflects new follows only, and does not account for "unfollows." For comparison with Twitter, the total number of new Facebook Fans does not account for unlikes or unfollows. Instagram only reports the net number of followers, including "unfollows," so the number of new Instagram followers reported is an underestimate when comparing to Twitter or Facebook.*

*** Instagram impressions are based on the average number of followers for that period.*

Figure 22. Number of Posts From The Crowd & The Cloud's Facebook & Twitter

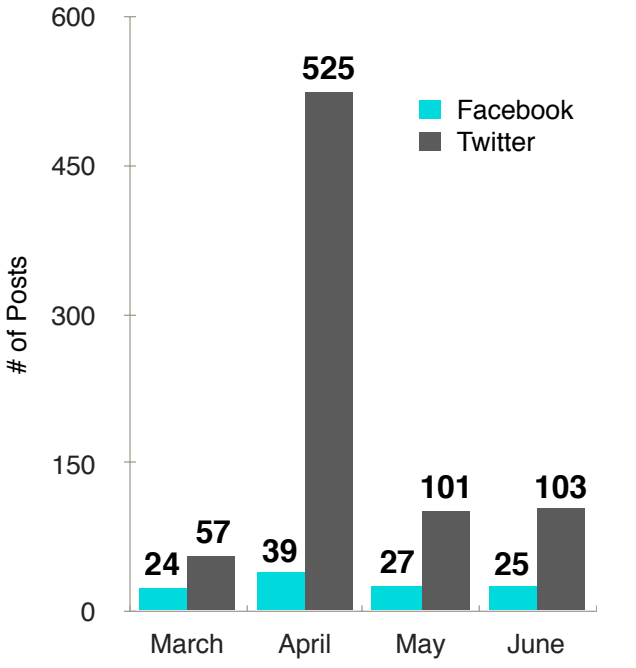
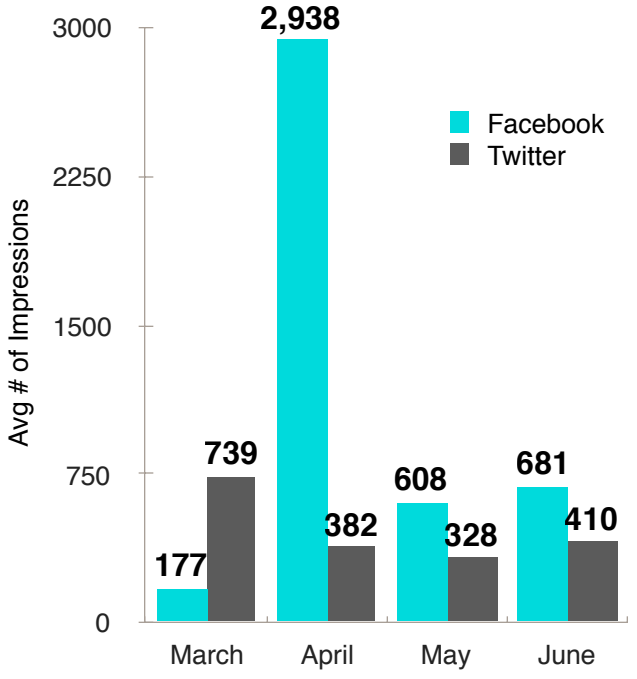


Figure 23. Average Number of Impressions Per Post From The Crowd & The Cloud's Facebook & Twitter



There are two ways to look at the “Top Posts” across The Crowd & The Cloud’s social media: The number of impressions (i.e., the number of times the content was displayed) or engagement (i.e., the number of people who not only saw a post, but also interacted with that post). On Facebook, engagement is indexed as the number of times anyone liked the post, shared the post, commented on the post, or otherwise clicked on the post. On Twitter, positive engagement is indexed as the number of times people re-tweeted or liked the post, which are the main two ways that audiences can provide positive feedback on tweets.

Based on impressions, the top post on Twitter (Audubon) had approximately 7k impressions, while the top post on Facebook (World Bank) had approximately 22.5k impressions. Based on engagement, the top post on Twitter had 54 positive interactions (retweets and likes), while the top post on Facebook had 759 unique users interact with it. These top posts on Twitter and Facebook are provided in Figure 24.

Figure 24. Top Posts on The Crowd & The Cloud’s Facebook and Twitter

Facebook

Twitter

Across the three social media platforms (Instagram, Facebook, Twitter), the most engaging posts tended to include images, and generally these images were colorful and contained little to no text. However, as each platform supports a unique audience culture, various strategies worked differently on each platform. On Facebook and Twitter, the most engaging posts tended to name someone identifiable from an episode (see Figure 25), had slightly longer character counts, and used more hashtags than the least engaging posts. The most engaging Instagram posts were colorful, featured high quality photography, and often showed animals or scenes that are difficult to capture or rare to see. The most engaging Facebook posts tended to include videos, whereas the least engaging posts tended to not have any video elements (see Figure 26). On Twitter, the most engaging posts tended to mirror some of the main ideas of the series (that citizen science produces high quality data in an efficient manner, and that anyone can participate), and tended to make value propositions, asserting that the benefits of participating in citizen science include having fun, solving scientific problems, improving health, reducing pollution, and helping one's community. However, the most engaging Twitter posts tended not to include information about technology used in citizen science projects. Across Facebook and Twitter, the more engaging posts also tended to reference Alzheimer's research. It is unclear if cross-promotion with popular events related to this topic or the salience of the topic itself explains the increased traffic and engagement.

Figure 25. Example of Top Facebook Post From May 2017, Mentioning Individual Citizen Science Participants

Facebook Use

Users tended to arrive at The Crowd & The Cloud Facebook page from search engines (40% from Google, 4% from Bing) or after visiting CrowdandCloud.org (45%).

Popularity of Posts

Facebook posts were ranked according to the number of engaged users over the lifetime of the post. Lifetime engagement is measured by counting the number of unique people who engage with the post by commenting, liking, sharing or clicking on particular elements of the post during the time that post is visible online. The top 10 Facebook posts from March to June 2017 tended to have the following characteristics:

- Included videos with little to no text (see Figure 26)
  - In March, the bottom five Facebook posts had no images or videos.
- Mentioned an individual or group affiliated with a citizen science project featured on the series or website (see Figure 25)
  - In April, the top 3 posts used a consistent format, featuring or naming a specific citizen scientist and inviting users to learn more about citizen science through their work.

Figure 26. Example of Top Facebook Post From June 2017,
Video with Minimal Text

- Cross-promoted a popular event in combination with mentioning a specific person (see Figure 27)

- In June, many of the most popular posts tended to refer to Watertown's Longest Day and the Hope Lap. Cross-promotion with these events likely supported higher traffic and post engagement, with event participants perhaps being more likely to engage with any coverage of the events.

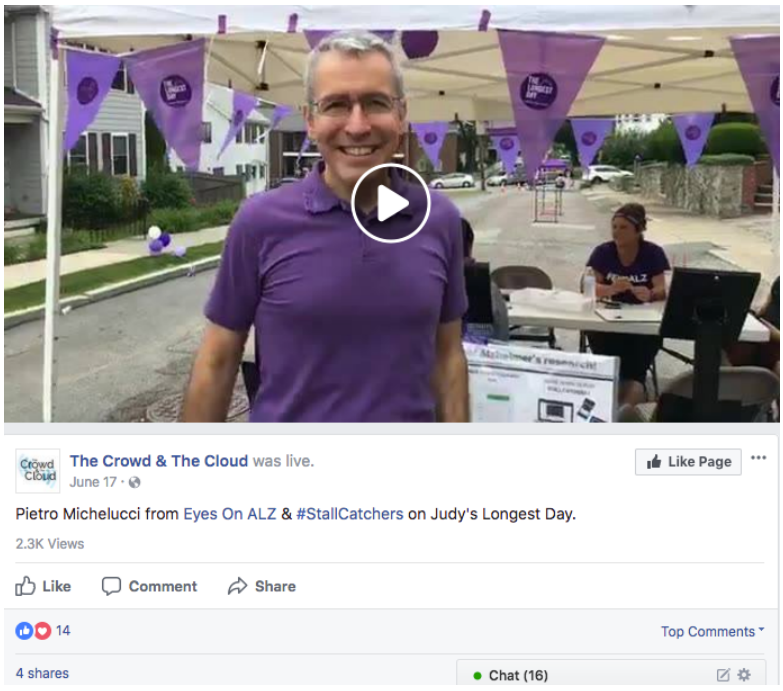
- Had slightly more characters
  - The top ten posts had 279 characters per post compared to the bottom five posts, which had 253 characters on average.

- Posted in April, in conjunction with the television broadcast air dates

There were not noticeable differences in the number of hashtags per post, nor were there huge differences in the prevalence of specific content topics.

The analyses above focus on engagement with posts to identify the top ten and bottom five posts in March through June 2017. A supplementary analysis examined the top performing posts which earned the most engagements and the most impressions (see Table 39, Appendix D). Among these seven top performing posts, which represent the intersection of the top ten based on impressions overall and monthly top ten lists based on the number of unique users who engaged with the post, five of these seven posts are about a specific individual featured on the series or website. This suggests that Facebook audiences were most interested in stories about actual citizen scientists.

Figure 27. Example of Top Facebook Post From June 2017, With Event Cross-Promotion



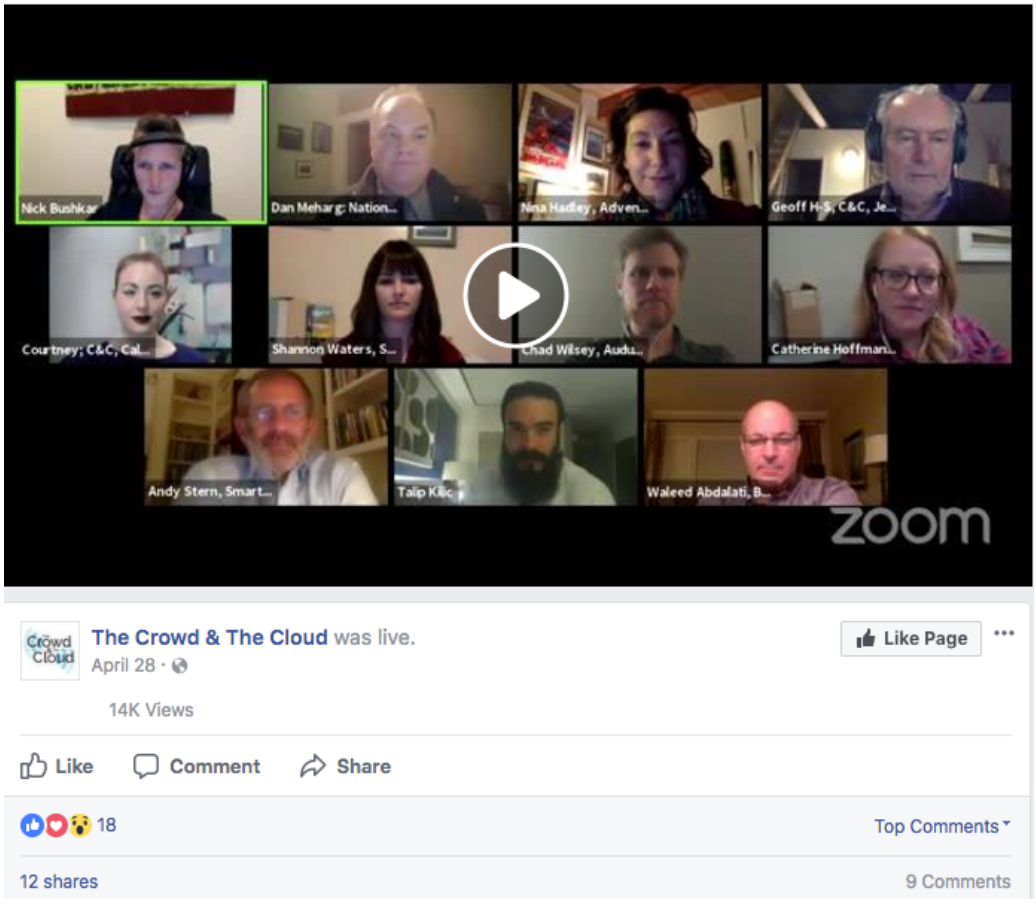
Among the top seven posts with the most impressions and engagements, the other two top-performing posts start with the words, "Join Us," followed by a date, and a location to "watch it on." Furthermore, almost all of these top seven performing posts (with the exception of one)

include a photograph. Several also cover the topic of Alzheimer's research and feature an emotionally evocative quote.

Facebook Video Elements

Users watched The Crowd & The Cloud's video content directly through the Facebook page. The top sixteen Facebook Video posts had 21.5K total viewers who watched a video for at least 30 seconds, but approximately 500 users watched any of these videos in their entirety (see Table 40, Appendix D, for list of top sixteen video posts). Videos on Alzheimer's research and The Longest Day events received the most in-depth engagement in terms of video completions (see Figure 26). Videos with the most unique viewers were interactive live Q&A sessions that took place after East and West Coast airings of each episode on WORLD Channel every Thursday in April (see Figure 28).

Figure 28. Example of Top Facebook Video Post From April 2017, Live Roundtable Discussion After Episode Broadcast

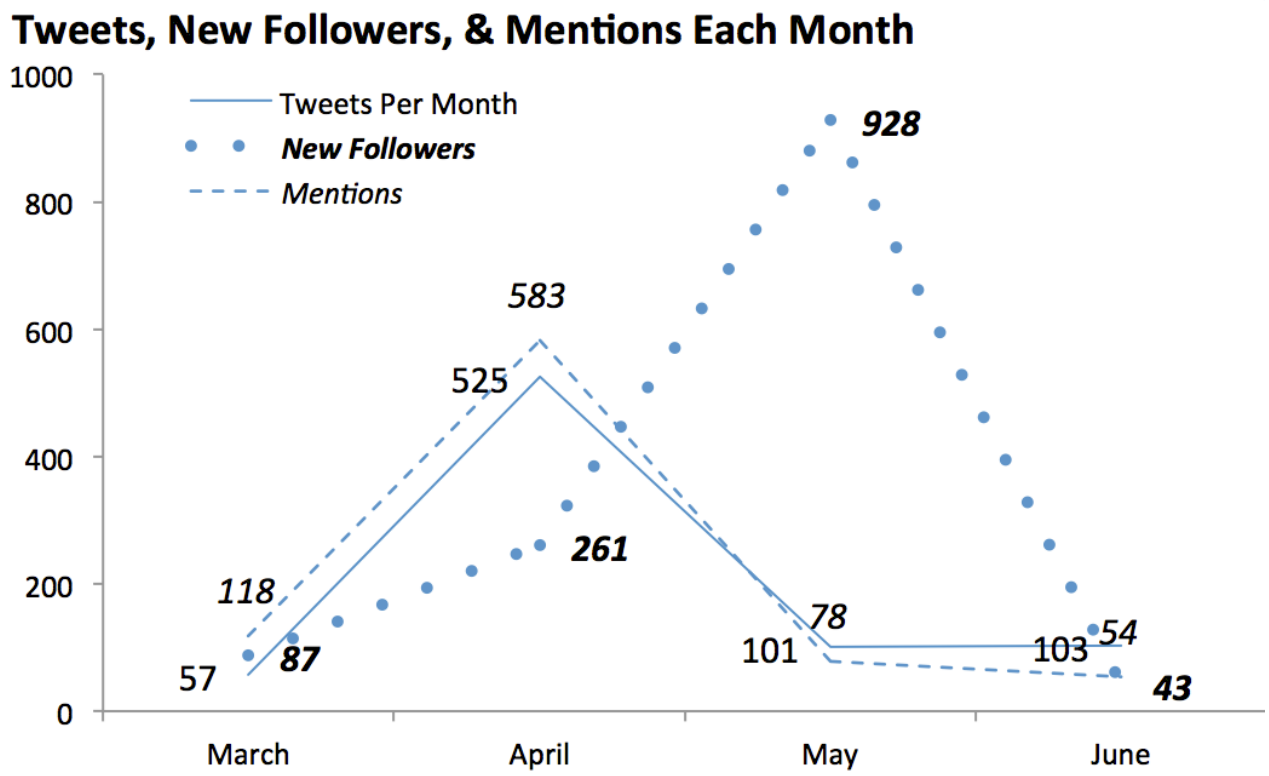


These live video hangouts featured Waleed Abdalati, the host of The Crowd & The Cloud series, the producers of the series, and representatives from citizen science projects who appeared in that evening's episode. The top two live hangouts occurred on April 27th for both the Eastern and Pacific broadcast of Episode 4. However, due to the length of these roundtable discussions, the drop-off in viewership was high, with only a few people watching the entire session.

Twitter Use

The number of tweets and new mentions peaked in April, which corresponded with the time period that episodes of the series were being broadcast across the country (see Figure 29). Mentions refer to the number of times that other users tweet to @CrowdAndCloudTV from their accounts. This includes replies to @CrowdAndCloudTV's posts and spontaneous tweets to Crowd & Cloud.The number of new followers on The Crowd & The Cloud's Twitter account steadily rose, peaking in May, even though the number of new mentions and overall tweets had diminished by this time.

Figure 29. Twitter Activity Each Month: Tweets, New Followers & Mentions



The top ten tweets and bottom five tweets from The Crowd & The Cloud's Twitter account were identified based on the sum of retweets and likes that the original tweets received (see Table 41, Appendix D, for a list of top ten tweets). Popularity of tweets was not based on engagement rate, which can appear skewed, if only a few people see the post (i.e., a tweet seen by 5 people and liked by 3 might have a higher engagement rate than a tweet seen by 100 people or more). The top ten tweets from March to June 2017 tended to have the following characteristics:

- Mentioned an individual from the broadcast series (see Figure 30)
  - The mention did not necessarily use the @ handle. These mentions consisted of naming a specific person within the text of the tweet, included a photo of a person with a quote and that person's name, or consisted of a text snippet with a link to an article.
- Included images or photographs
  - On average, the top ten tweets had .9 photos, whereas the bottom five tweets had .1 photos.
  - Many of the most engaging tweets included large, colorful graphics with The Crowd & The Cloud logo, pictured people and/or quotes, or included detailed event information, including specific dates and times of upcoming events.

Figure 30. Example of Top Tweet Mentioning Citizen Science Participants from Broadcast Series

In Ep 4 "Citizens4Earth" we meet conservationists capturing data to protect pollinators, butterflies, & more #CrowdCloudLIVE #CitizenScience

- Had more characters
  - On average, the top ten tweets had 145 characters, whereas the bottom five tweets had 126 characters[8].
- Had more hashtags
  - On average, the top ten tweets had 1.98 hashtags, whereas the bottom five tweets had 1.1 hashtags.
  - Many of the top tweets featured hashtags that referenced specific events (i.e., #longestday2017).
- Had links to other webpages
  - On average, the top ten tweets had .73 links, whereas the bottom five had .5 links.
- Used positive emotions (Hope, Thrill, Excitement, Fun, Human interest) (see Figure 30)
- Included the words, “Join us,” with information on how to participate in an event
- Referenced Alzheimer’s research (i.e., #EndALZ)
- Tended to occur in April, coinciding with the broadcast episodes
- Addressed The Crowd & The Cloud’s core messages that anyone can participate in citizen science, that citizen science produces high quality data in an efficient manner, and that citizen science helps address scientific and community issues (see Figure 24)

Tweets that made the bottom five each month tended to be requests for questions to answer during the live roundtable discussions, or shoutouts to individual stations letting them know that The Crowd & The Cloud website has extra content.

Instagram Use

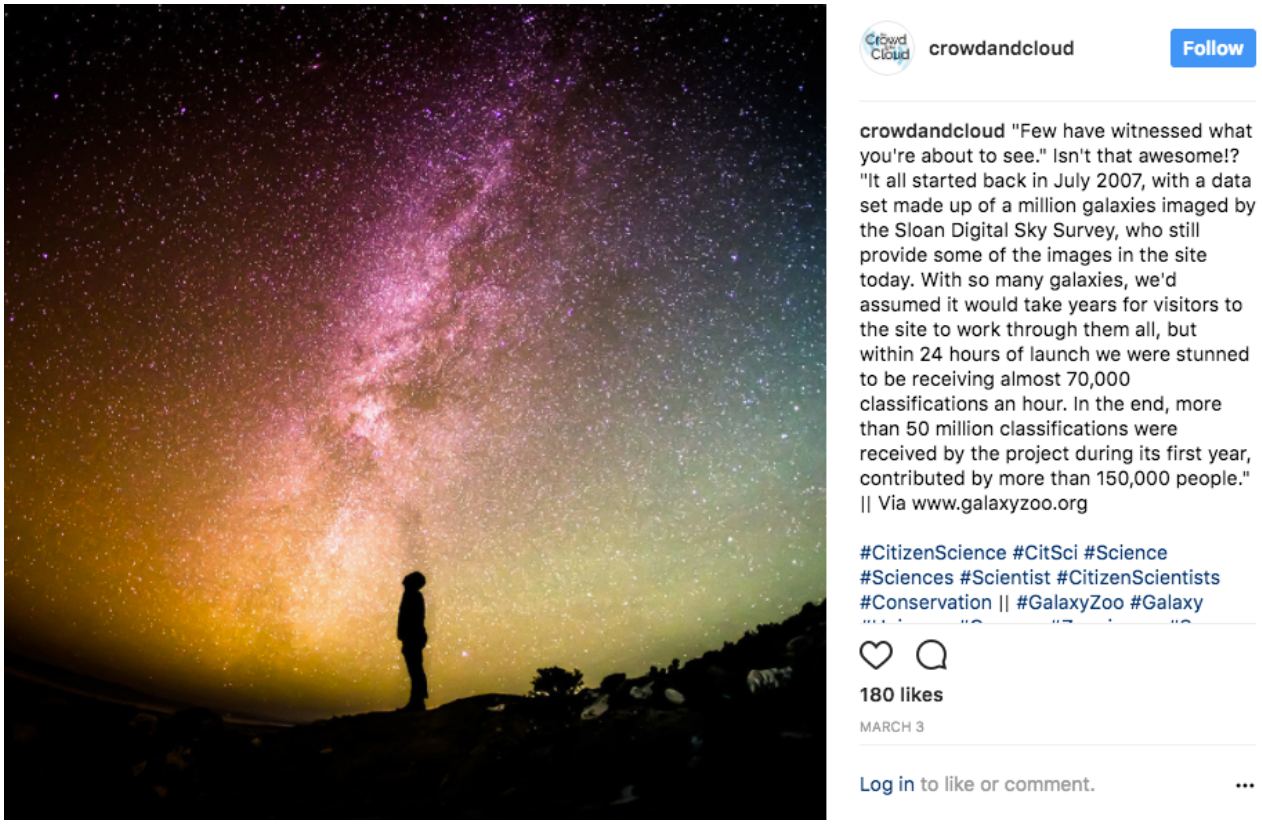
Users’ engagement rate on Instagram was based on the number of likes and comments received divided by the number of followers at the time of the post. The most engaging Instagram posts had the following characteristics (see Table 42, Appendix D for list of top ten Instagram posts):

[8] Character counts include URL's with embedded media attachments, which do not count towards Twitter's former 140 character limit.

- Were colorful
- Featured high quality photography (see Figure 31)
- Showed animals or scenes that are difficult to capture or hard to see in nature (see Figure 32)

The comments, likes, and growth in followers associated with such posts are one indicator that these posts were successful in spreading interest in and awareness about citizen science, and inspiring participation. Posts that featured a citizen scientist from the series with a text quote were less popular on Instagram whereas they had been popular on Twitter and Facebook. This finding suggests that users prefer different types of content on the different social media platforms. The least popular Instagram posts were text-heavy and followed a uniform design using the same layout, font, and monochrome colors. The four least liked posts overall (receiving less than 100 likes each) and nearly all the posts in May followed this format. In addition, posts in May received the least number of comments, leading to May being the lowest performing month on Instagram overall.

Figure 31. Top Instagram Post with High Quality Photography

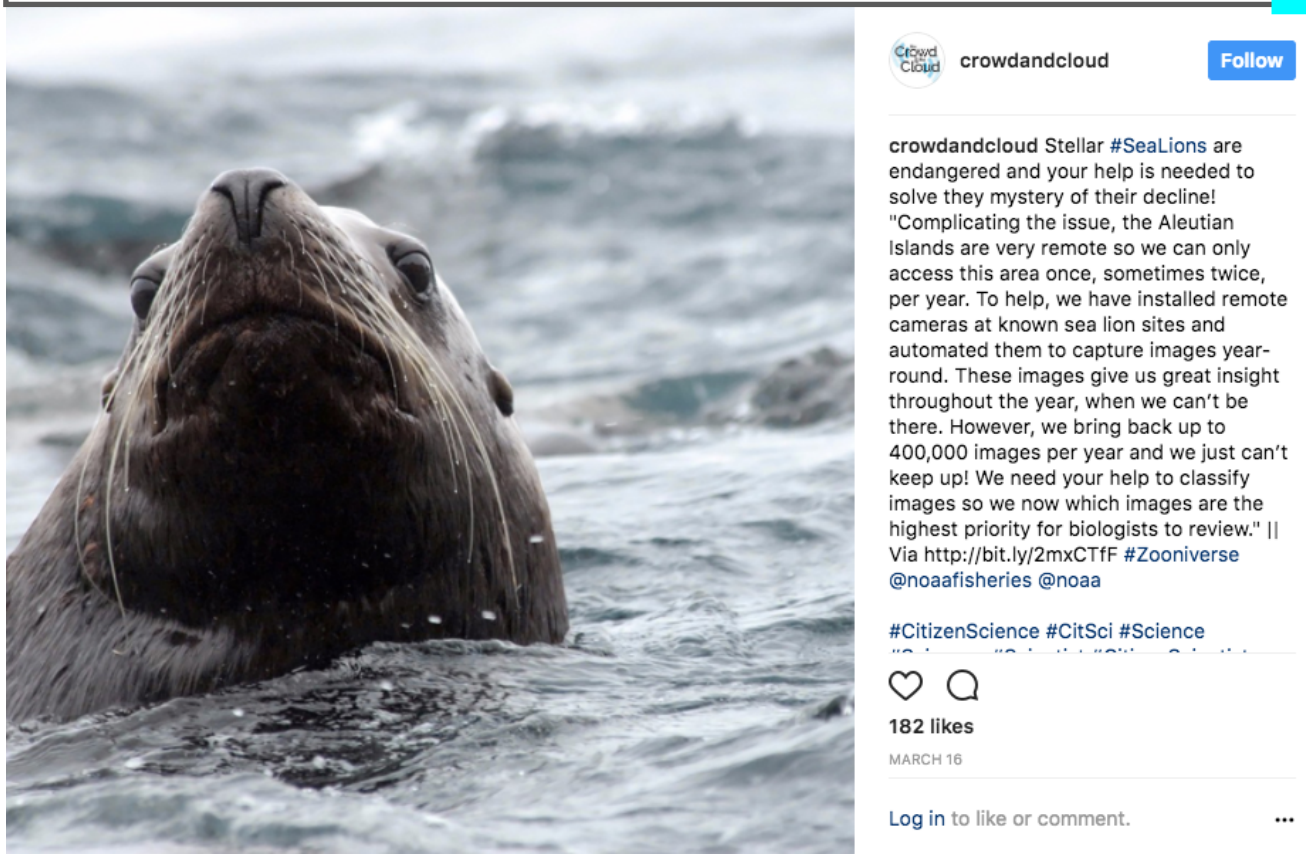


Information about the least popular posts can also be inferred by looking at posts on days when the most Instagram followers were gained or lost (see Table 43, Appendix D for posts with the most growth in followers). Nearly all of the larger gains in the number of followers happened in March as The Crowd & The Cloud's social media presence was gearing up in anticipation of the April broadcast premiere of the series. The increase in followers likely reflected the novelty of the content, as well as the presence of images featuring high-quality photography. As with engagement rate, posts that lost the most followers had lower-quality images, were text heavy, and sometimes included a citizen scientist with a text quote. The positive comments left on some of these less popular posts suggest that a segment of the audience still supported the posts' content and message, even though the posts were less well-received by others. For example, the following comments were left on a less popular post linking to the previous evening's live roundtable discussion:

Loved seeing you on PBS last night, it was awesome!

I need to check it out! Citizen science is the future.

Figure 32. Top Instagram Post with Animals



Overall Opinions About The Crowd & The Cloud's Social Media

Overall, The Crowd & The Cloud's social media campaign was successful in engaging audiences across the three platforms: Twitter, Facebook, and Instagram. Use of social media was effective at extending the reach of the broadcast series and provided additional ways for audiences to learn more about and become involved in citizen science. Online focus group participants who used The Crowd & The Cloud's social media saw these platforms as an avenue to share information about the series and the topic of citizen science with their communities. For example, one participant indicated that she had posted the link to The Crowd & The Cloud website on her Facebook page to share with her friends and family. Focus group participants also saw The Crowd & The Cloud's social media as a great tool for announcing upcoming projects that they could take part in, such as viewing a summer 2017 eclipse.

Focus group members of all ages thought that social media platforms are an important way to try to engage younger audiences: *"Social media is how younger viewers are consuming media."* One participant added that younger audiences view the majority of their television content online and that the value of the project website and social media is in *"prolonging the longevity of The Crowd & The Cloud, particularly for people who don't watch it on TV. There are a lot of people who may be interested, but who aren't going to watch the show on TV."* Thus, to reach as broad an audience as possible, it is essential to have a strong social media presence.

> **"[Social media] was a way of getting many different types of viewers connected to the material. It was a way of putting small chunks of materials out to whet their appetites, and to excite and bring attention to the field, and to mobilize people around participation."**
>
> **- Project Advisor**

Citizen Science Project Leaders' Perspectives on The Crowd & The Cloud's Broadcast & Digital Media

Thirteen leaders of citizen science initiatives featured in The Crowd & The Cloud broadcast series or on the website were interviewed about the impacts of the project on their initiative. Project leaders all felt that their projects' inclusion in The Crowd & The Cloud lent their efforts some additional recognition:

> *We always looked at ourselves as a grassroots, fun-loving, low-budget, shoestring type of thing. But to be included in such a professional piece and directed by such an accomplished individual, it was just such an honor.* (CoCoRaHS)

> *Some people who visit our booth at public events recognize the project from the documentary. It added credibility and legitimacy to the work.* (EyesOnAlz)

> *I am amazed everyday that we are getting the recognition we are getting. People are recognizing what something like this can do on a much broader scale. I look at it as, 'This is a fantastic tool that patients and doctors can use. When it started to evolve into much more than this and I saw the interest this was getting, it was an eye opener for me from my background that something like this could produce these results at the policy level.'* (Propeller Health)

> *The exposure is important in two ways. It's obviously important when people Google search us and these projects come up, it really legitimizes us and our work. It's also powerful in reverse more internally in validating and encouraging the people in our organization and the people around our organization who do the work or may want to support us in this work. It has those two benefits like all good public relations has.* (West Oakland Environmental Indicators Project)

Project leaders also felt that their participation in the series lent credibility to their projects in the eyes of local and government organizations:

> *Participating in these programs and being publicly broadcasted is helpful to demonstrate how valuable improving public health is. We need to prove that we are worthwhile as a company. In terms of who we are and how we are presented, it was very helpful.* (Propeller Health)

> *The agencies that were watching it, they had a lot more tolerance for what we were doing, maybe because they knew other people were watching as well…It definitely added an air of credibility and respect to the project because it was prominent enough to be featured on a national show.* (Philly Unleaded)

> *It's this kind of work that's going to change the face of public policy in the future. It's going to change the face of regulation…Without programs like The Crowd & The Cloud featuring the leading edge organizations like ours and all the others in the [series], there wouldn't be a groundswell of interest among researchers and regulators.* (West Oakland Environmental Indicators Project)

Yet, some leaders wondered how to capitalize on being a featured project, and wanted more guidance on how to promote the series:

> *We're interested in getting the word out, but who do you get the word to and how do you change behavior?* (Nature's Notebook)

> *We were not able to generate a big awareness campaign around [The Crowd & The Cloud] for our organization.* (West Oakland Environmental Indicators Project)

One leader thought that having downloadable clips from his project's segment in various file formats would be helpful for media campaigns and grant proposals. Another leader from Trout Unlimited indicated that he already linked to such clips and used them as a communication tool to reach out to potential volunteers and organizational partners. Similarly, leaders from CoCoRaHS leveraged the series and website for cross-promotion and recruitment in their own activities: *"We learned that we could do more with communications with our volunteers and community. We could build off of what The Crowd & The Cloud was doing, both to help drive more viewers to see not only the episodes as they were presented, but also the behind-the-scenes media that were supporting and advancing citizen science."* In sum, although a few projects did utilize their segments after broadcast to try to get the word out, leaders identified media promotion as an issue for the field, in general: *"We almost never talk about things like, 'What kind of press did you get?' We probably should talk about it strategically, but we're in the trenches trying to figure out how to get action for the work,"* (West Oakland Environmental Indicators Project)

"Without programs like The Crowd & The Cloud featuring leading edge organizations like ours and all the others in the [series], there wouldn't be a groundswell of interest among researchers and regulators."

- Citizen Science Project Leader

> **"[The Crowd & The Cloud] has a huge impact on the visibility of our project during a critical stage of building a community of volunteers."**
>
> **- Citizen Science Project Leader**

One leader felt that her involvement helped her think more strategically about how to communicate about her project, Mosquito Alert, with various stakeholders and funders. Another leader said that tweeting about and linking to the series and website had helped him *"become more attuned to social media."* A leader from Smartfin noted that The Crowd & The Cloud *"has given me platforms to talk about ocean health and environmental concerns and climate mitigation that I wouldn't have been able to access otherwise,"* as well as access to new audiences. He shared that his involvement in The Crowd & The Cloud helped him emphasize the citizen science aspects of his project, as well as present and target his work for like-minded project leaders at the bi-annual Citizen Science Association conference and via other outlets, such as magazine articles. A leader from the Propeller Health project indicated that being featured on The Crowd & The Cloud led to increased attention from media outlets, and helped *"crystallize"* her project's connection to the citizen science movement. Another leader appreciated that his project's segment represented a moment in time that he could look back on and understand where his project had been and how it had grown.

Project leaders experienced varied results in terms of gaining new citizen science participants. One leader from CoCoRaHS felt that, *"It would be impossible for people not to join, given how widespread the series was."* He shared that they ask new participants to fill out an open-ended question stating how they found out about the project. Although not everyone fills out this form, he indicated that 175 individuals mentioned The Crowd & The Cloud as the reason they had joined. He went on to say,*"For the history of CoCoRAHS, we have only been able to tap into the low-hanging fruit - people who are already tracking the weather. Now we are tapped into people who are interested in helping with science."* His colleague added, *"A lot of our target audience out there are the NPR, PBS types of folks that watch that stuff. I think it probably resonated with people who are not yet observers to do this project. I think it made a lot of people aware of what we do. It's good publicity for us."* The project leaders also noted that online analytics from SciStarter.com indicated some cross-connection with other projects - namely that those who signed up for EyesonAlz then signed up for CoCoRaHS.

Another project leader from Smartfin indicated that he had received inquiries from all over the world, and posited that some of those came from the show. He also observed increases in

the project's website and social media activity after the series aired, noting that 100 new visitors went to the project website on April 27th when Episode Four aired, and 247 new visitors came to the website that week. One leader of a pilot project that was already over by the time the series aired, Propeller Health, noted that that The Crowd & The Cloud still *"opens a lot of doors for us. 'We saw what you did. We would like to be involved. We would like to get that in our city.'"* She shared that other cities had contacted them that wanted to employ a similar asthma and air quality study.

The strongest evidence for an increase in citizen science participation comes from the leaders of the EyesOnAlz project:

> [The Crowd & The Cloud] h*as a huge impact on the visibility of our project during a critical stage of building a community of volunteers. We have graphs [see Figure 33] showing tremendous growth immediately during and following the premiere of The Crowd & The Cloud, and thereafter in other events supported by The Crowd & The Cloud social media campaigns and live hangouts. The Crowd & The Cloud has been indispensable to engaging the general public in the EyesOnALZ project and Stall Catchers platform. I would go so far as to say it was a key success factor in community adoption and engagement.*

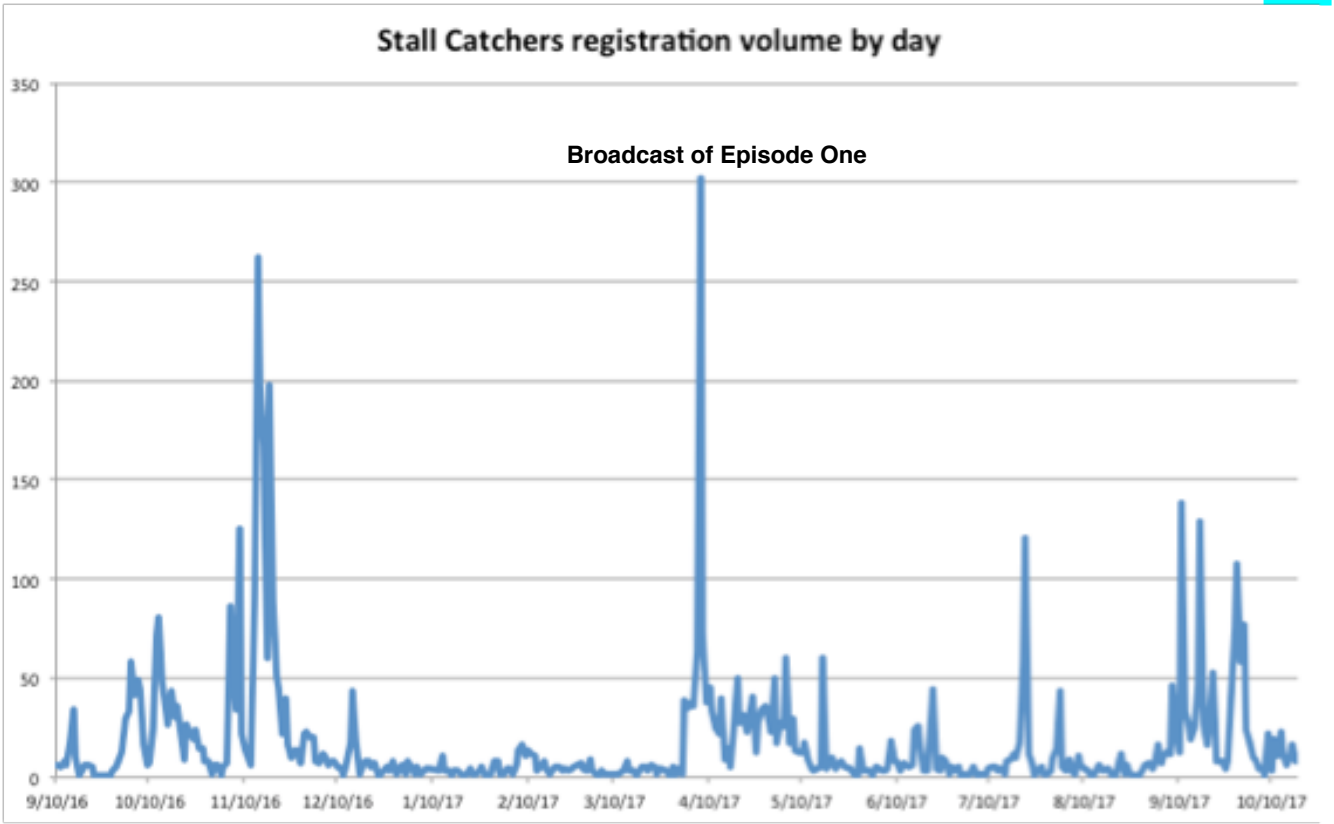
This growth includes an entire Idaho middle school that joined the project as a result of an educator seeing The Crowd & The Cloud. In addition, project leaders claim that the StallCatchers platform now analyzes Alzheimer's research data three times faster than before the series aired.

"In the region that was highlighted and in our volunteer base, in general, it provided a sense of pride and legitimacy to their efforts."

- Citizen Science Project Leader

Several project leaders felt that The Crowd & The Cloud energized their current volunteer base. A leader from Trout Unlimited noted that the segment on his project was affirming to his volunteers and for the local community: "*In the region that was highlighted and in our volunteer base, in general, it provided a sense of pride and legitimacy to their efforts, seeing it be highlighted to such a large audience."* He added, "*We had quite a few folks who are volunteers with us respond, saying how cool and exciting it was seeing their project nationally televised. They had some feedback about how their efforts fit into a larger context… Anytime you're getting folks to proactively provide feedback like that and to provide additional interaction between myself and the volunteers, it's helpful for retention."*

Figure 33. Increase in EyesOnAlz Participation After The Crowd & The Cloud Broadcast



A leader from CoCoRaHS thought that utilizing The Crowd & The Cloud's broadcast and digital media would lead to a similar outcome for current volunteers: *"We promoted our project, encouraging our volunteers to both watch the episodes on television and follow along with the other online activities that support it. We found that it solidified our base that already loved the project and felt prouder of the project as a result of seeing the project featured. It's likely to lead to a longer term commitment to the project as a result of that pride."*

A leader of the Eclipse Mega Movie project, which was only featured on The Crowd & The Cloud website, thought he could see participants' enthusiasm in the posted videos: *"You can tell how excited and happy they were to represent our project through The Crowd & The Cloud. These moments can really make someone's life feel very special and feel more valuable. I'm sure it gives a huge uplift to people who are hopefully inspired to do more and get their associates and others they know to get involved."* A leader from the West Oakland Environmental Indicators project concurred, *"When she's working and she sees herself and*

seeing that she's being recognized in a really significant way, that's a very powerful motivator for her and raises her self esteem about the work she has been willing to do."

One leader from the Philly Unleaded project, who had not know what citizen science was before his involvement in The Crowd & The Cloud, shared that seeing other featured projects doing similar things was *"energizing"* for his own work. He added that the series had given him *"a different way to think about how projects are started and run and completed. It's made me think a lot more about taking a citizen approach in projects I work on professionally."* A leader from the West Oakland Environmental Indicators project summarized:

> *We are encouraged to continue by the opportunity to participate in things like The Crowd & The Cloud. If it seemed like no one ever cared, we'd probably drift into other work that we felt served our community. If no one ever funded documentaries about community participatory research and we were never interviewed about it or talked about it, we probably couldn't sustain our own interest in the long term. The program is really important in that regard, in helping to keep us going and giving us a reference point.*

Another outcome of being featured on The Crowd & The Cloud was forming new collaborations and connections. A leader from the West Oakland Environmental Indicators project shared that their participation in the series led to a new partnership and application of their air quality monitoring technology: *"Our work around backpack monitoring featured in the program has led directly to an organization like Environmental Defense Fund reaching out and asking us if we wanted to participate in a partnership with Google using air mapping using the Google Earth View cars. Now, they could have gone to some other community, but they came to us because we have a very high profile due to programs like The Crowd & The Cloud."* One leader from CoCoRaHS experienced an uptick in individuals asking for weather data after Episode One of the series aired. Similarly, a leader from Trout Unlimited was contacted by a university researcher after broadcast to find out if she could analyze some of their data. A leader from Propeller Health indicated that her involvement in The Crowd & The Cloud led to conference presentations and fostered a research partnership that led to a National Science Foundation grant submission. A leader from the Philly Unleaded project shared that he had been able to secure a meeting with city council members because of the positive coverage his project received in the city of Philadelphia during filming. Another leader from the EyesOnAlz project stated that his team has *"nice relationships with members of the Alzheimer's patient and caregiver community due to the [The Crowd & The Cloud], which has led to further direct engagement between our platform and that community,"* and has attended events with patients and families featured in Episode One of the series as a result. Multiple project leaders indicated that they had been contacted by individuals or groups, but were still in the process of transforming those connections into concrete actions: *"Nothing that has*

become or panned out to something specific yet, but there were some connections made that didn't exist previously that could serve fruitful in the future," (Trout Unlimited)

Leaders also shared that their involvement in The Crowd & The Cloud strengthened existing partnerships. For example, a leader of the Mosquito Alert initiative indicated that being featured helped promote her project and strengthened relationships with other groups addressing mosquito abatement around the world. Similarly, the CoCoRaHS project became more involved with the SciStarter online platform after participating in The Crowd & The Cloud filming. They also solidified a current partnership with the National Weather Service: *"The National Weather Service was featured in the show, how they use our information. It was done in such a professional, high-level way that some of the high-level administrators in the National Weather Service had to sit up and take notice because we're sort of at the low end of the radar and that elevated that. That was a reinforcement of an important partnership that we already have."*

A few leaders called out specific messaging from the series, both positive and negative: *"I think it definitely was a good balance of talking about the successes and the issues that have come up…I noticed that in a couple other segments that I watched, they talked about challenges that groups were having. I think they did a good job of talking about the pluses and the minuses."* One woman from the Mosquito Alert initiative appreciated that the series addressed data quality assurance, as this was an issue she encountered with data submitted to her project's app. A man from the Eclipse Mega Movie project liked that the series showed projects that were in the beginning stages and how they iteratively designed interfaces to ensure that they worked well for participants. A project leader from the West Oakland Environmental Indicators project also appreciated that the episodes featured projects of various scales and time points. Another project leader from Nature's Notebook liked that his technology was featured in multiple segments, indicating its broad applications. However, he felt that the series did not address issues of retention in terms of strategies for convincing participants to commit to repeated monitoring over time. Leaders from the CoCoRaHS project felt that their segment had contributed to two small misconceptions (i.e., that participants were required to take measurements everyday, and that it is difficult to collect data in rural areas). They also thought that their project was portrayed as more exciting than it is in practice: *"It may have come across as saving lives and stuff like that that are a little more dramatic than the day-to-day observations of climatology."* However, they liked that the series as a whole showed that *"there is a lot that can be done when people come together with crowdsourced data."*

The Crowd & The Cloud undoubtedly increased public awareness of the projects it featured. Being involved in the series also helped projects recruit citizen science participants, form new

partnerships, and strengthen existing collaborations. A project leader from EyesOnAlz summarized:

> *From our own experiences and in talking with other project stakeholders whose work was featured in the documentary, it seems crystal clear that The Crowd & The Cloud has directly impacted project successes and more generally connected the notion of citizen science to the general public, blazing a trail for future such engagement and acceptance of both citizen science and science, in general.*

Citizen science project leaders appreciated that The Crowd & The Cloud raised the general public's awareness of the existence of citizen science: *"I think it's just taking it one more much-needed step forward. As someone who's been watching the citizen science phenomenon grow and grow and grow, to bring it to new audiences and certainly get it in people's living rooms was much needed."* They felt that the series helped individuals see that anyone can do science:

> *It has been a neat eye opener for the community that hadn't heard about it or not known how easy it was for a random person to do it.*

> *Science is intimidating and not easy to understand and hear in a way that is compelling. Citizen science makes the science accessible...When you see citizens that people can identify with engaged, it pulls people in. It opens minds to science.*

Project leaders thought the project might help people see that they can address issues in their own communities using citizen science:

> *Just the general exposure to citizen-led science in such a thorough and lengthy way was just a great introduction to many people that they can get out there with very limited resources and make change….Lower income communities who feel disenfranchised and feel like they don't have the power, I think that was very empowering to them. They don't always realize that they can take charge themselves and do some work themselves to find answers to the problems that they're having.*

> *I think it will certainly expand participation. It will bring much needed awareness to the fact that anyone can contribute to scientific discoveries and not feel that that is only done by the experts and they really have no part to play. I think through The Crowd & The Cloud, the phenomenon will only continue to gain momentum and be seen as sort of the amazing ability for collective action to really make a difference.*

They hoped that awareness of citizen science would lead to participation, echoing the project's goal of turning viewers into doers:

I would hope that folks who were just at home and had the show on may have seen this world of citizen science they didn't really realize existed previously, and increased their awareness of those kinds of opportunities. Maybe they'll proactively search out opportunities in citizen science, or be more receptive or recognize citizen science opportunities that might come their way in the future.

Seeing how pervasive it is and the many forms citizen science is taking, it is informative and it helps people think about how they can get involved.

Project Advisors' Perspectives on The Crowd & The Cloud's Broadcast & Digital Media

Twelve advisors for The Crowd & The Cloud project were also interviewed regarding their understanding of the goals of the project, thoughts about the successes and challenges of the broadcast and digital media, and how they saw the project contributing to the larger field of citizen science. Advisors were impressed by the scope of the series and number of citizen science projects featured:

Citizen science is so vast, diverse and complicated, to weave it all together, is impressive.

As someone doing citizen science, what I think it did was to do a nice job of demonstrating the range of things that are already going on that involve citizens doing useful data collection. Publicizing more of the whole movement to do this.

They felt that the series capitalized on a *"timely opportunity and need to showcase the real explosion of citizen science across so many disciplines."* They also liked that the series showcased *"a range of ways the public is engaged in research, not just online or in the field."*

"Getting that kind of prominent attention, on air and on the website, would be one of the most effective ways the field would have to bring knowledge about citizen science to people who haven't heard about it."

- Project Advisor

Advisors appreciated the various messages they felt the show conveyed. Several advisors mentioned the idea that anyone can do citizen science was a core message of the show:

> **"One of the points was that scientists are no longer alone. With smartphones and cameras, it's becoming easier to get an ordinary citizen involved."**
>
> **- Program Viewer**

Citizen science works. Non-experts can make significant contributions to scientific research in ways that are really exciting to both the public and the scientists.

Science can be for everybody. Anyone can do science, and you can have a real impact.

The episode about CoCoRaHs, the scenes with the people measuring the snow, came across as regular people…In Philadelphia, I felt like I was right there in the kitchen.

One of the first points Waleed made in the programs was that some real science can be done with data collected by real people.

Two advisors were pleased to see the series explore how everyday citizens become empowered to solve problems in their own communities:

This isn't working so we have to do it. You can't wait for government to solve it. You have to do it yourself.

The examples shown highlighted that quite well - how local problems, local people, local movements, local crises were, in fact, informed by citizen efforts. I would say that was a crowning success of The Crowd & The Cloud, demonstrating some of those tough, local problems that are hard to get traction on, and how the citizen involvement, in fact, had a greater impact in many cases than federal or regulatory.

Another advisor liked that the series showcased how people do citizen science, and not just on findings: *"The show also did a good job about talking about the process and the promise, and not having to focus so much on the outcomes of the project. Sometimes it feels like the volunteers are held to a higher standard to generate outcomes. But science is a process."* Similarly, an advisor added that he liked that the series *"[focused] on one or two of the citizens who were doing science and what it meant to them. I found them to be very compelling and powerful."*

Another issue that advisors thought that the series handled well was around data quality:

The central concept of citizen science is that people can make contributions to science and participate in doing science. If the system is set up where the data collected by citizens is valid, then scientists will pay attention to that data and use it.

There's always going to be people who will question or challenge, but each project has to defend its own data quality based on some quantitative references. Seeing the way the data were being collected and the ways The Crowd & The Cloud put it together, it raised the bar…I think The Crowd & The Cloud showed that the standards are really quite high and the value is really sufficiently high in data being collected for a variety of purposes.

The advisors also praised the multimedia approach for The Crowd & The Cloud (i.e., that the project was not limited to a broadcast series): *"Thinking about the social media and the website, how do you create these resources for the participant journey from watching the [series] and in the end teaching about doing something?"* For example, one advisor was impressed by the breadth of social media platforms utilized and the reach those venues had: *"It was a way of getting many different types of viewers connected to the material. It was a way of putting small chunks of material out to whet their appetites and to excite and bring attention to the field, and to mobilize people around participation."* Another advisor noted that because the series is online, it is easy to direct people to it. Similarly, one advisor felt that the series *"stimulates people to think about all of the citizen science opportunities,"* and was a *"feeder program or on-ramp to websites that allow people to participate in different types of [citizen science projects]."*

Advisors felt that The Crowd & The Cloud drew more attention to the field of citizen science as a whole:

The show itself was a wonderful entry point for people.

To bring attention to the compelling and underappreciated power and impact of citizen science around the globe and the deep ways that communities and scientists are working together to use science to address problems.

The most important goal is to raise public awareness about citizen science. That citizens can contribute data and that we can use the technologies available to do that. The public's consciousness about citizen science needs raising. The Crowd & The Cloud was a way to do that.

Getting that kind of prominent attention, on the air and on the website, would be one of the most effective ways the field would have to bring knowledge about citizen science to people who haven't heard about it.

They also indicated that the project media gave them a way to talk about their own work with others:

> **"As someone who's been watching the citizen science phenomenon grow and grow and grow, to bring it to new audiences and certainly get it in people's living rooms was much needed."**
>
> **- Citizen Science Project Leader**

When someone asks what I do. I have them watch a clip and that explains it.

It relieves a burden for trying to come up with how to explain something. It was really unique. I don't think there is anything out there that has this type of quality.

Advisors liked that the series captured a moment in time for the field: *"It will be a historical documentation of citizen science of where it stood in the mid-two thousand teens."* They also felt that The Crowd & The Cloud helped legitimize the field in the eyes of government officials:

> *In the early days, they would say citizen science is just a niche. Saying that there is going to be a national television series got it out of being considered just a niche. It got it to be on a national level to influence the perception on citizen science.*

Furthermore, advisors saw The Crowd & The Cloud as a way to not only raise awareness of citizen science, but to encourage the general public to participate:

> *What I thought I was seeing was an effort to introduce and expose many more people to the concept of citizen science and the opportunities that are available and the amazing things that have already been accomplished with citizen involvement in that sort of science, and then just to present - confront people with what is important to them and see that individuals can make a difference and they can pick and choose between many amazing projects to get involved with.*
>
> *It was successful in eliciting a response from people who not only viewed and learned, but did in fact act on what they saw (i.e., volunteered to be part of a project).*

In sum, citizen science project leaders and The Crowd & The Cloud advisors thought that the broadcast and digital media positively impacted the field of citizen science by conveying important messages about the nature and value of citizen science, raising the public's

awareness of the existence of the citizen science movement, and increasing the likelihood that the general public would participate in citizen science activities.

Conclusion

From smartphones to sensors, The Crowd & The Cloud highlighted how citizens can use innovative technologies to capture and/or crowdsource scientific information. The series had a wide-reaching impact on viewers' understanding of, attitudes towards, and behaviors around citizen science. Initial awareness of the topic was seen as an important step towards deeper understanding. Each of the three target audiences — the general public, scientists, and citizen scientists — had differing degrees of familiarity with the concepts of citizen science and crowdsourcing prior to viewing the episodes. The general public, in large part, was unfamiliar with citizen science prior to watching an episode of The Crowd & The Cloud, but demonstrated a thorough understanding of related concepts, including how technology is used in citizen science projects, afterwards. While citizen science participants were familiar and scientists were somewhat familiar with citizen science prior to viewing an episode, the series expanded their understanding of the range of applications of citizen science and the extent to which citizens can engage in scientific practices.

Viewers' beliefs about who can collect data and the quality of that data also shifted as a result of watching an episode of the series. Citizen scientists already believed that ordinary people can do citizen science and that the data they collect is as valid as data collected by scientists. However, scientists and members of the general public who watched an episode were more likely to believe in the validity of citizen-collected data than those who had not watched the series. Furthermore, members of the general public who viewed at least one episode were also more likely to feel that anyone can do citizen science. Unsurprisingly, citizen scientists already held strong beliefs about the importance of their work, regardless of whether they viewed an episode of the series or not.

The series also motivated viewers to become involved in citizen science initiatives within their communities and online. In particular, members of the general public expressed an increased likelihood of participating in a citizen science project after watching an episode. The series showcased a variety of projects in which people with different backgrounds could see themselves contributing. The general public's confidence in their ability to do and talk about citizen science increased after viewing.

Each of the three target audiences were informed and impressed by the range of citizen science projects portrayed in the episodes and by the kinds of technologies that allowed for sophisticated data collection by non-scientists. Focus group participants and survey

respondents sought out additional information about citizen science and projects featured in the episodes, with some transitioning from viewers to doers.

While the series initiated viewers into the citizen science movement and introduced them to the breadth of projects available, The Crowd & The Cloud's website and social media provided the means for viewers to investigate citizen science in more depth, and ultimately to take action themselves. In particular, the website provided users with additional information about citizen science, as well as a way to explore and become more involved in citizen science initiatives. For example, the website increased users' familiarity with and understanding of citizen science. Website users were also more likely to agree that anyone can be a scientist, that data collected by citizens is valid, and that data collected by citizens can be published in scientific journals.

In addition, The Crowd & The Cloud's website activated users to engage in citizen science-related activities. Those who used the website were significantly more likely than those who had not visited the website to keep up with recent citizen science news and research, visit citizen-science related websites, and post about citizen science on social media. They were also more likely to investigate citizen science projects in their geographic area and indicate an interest in participating in a citizen science project in the future. Since the website was designed to include a searchable database of citizen science projects people could join, these findings represent a proof-of-concept that the website supported everyday people in moving from passive users to active participants in citizen science.

The website was also more effective at eliciting certain outcomes from users than the broadcast series. Compared to those who only viewed an episode, those who used the website were significantly more likely to feel confident in their ability to contribute to meaningful scientific research and in their ability to analyze and interpret data. They were also more likely to believe that anyone can be a citizen scientist. In addition, website users were significantly more likely than broadcast viewers to visit citizen science websites, investigate citizen science projects in their local area, and participate in citizen science projects in the future. The website's more interactive interface likely contributed to users becoming more confident and involved in pursuing citizen science-related information and activities.

The information available on the website was designed to be utilized in conjunction with the broadcast episodes or to stand alone for users who had not yet watched the series. When website users also watched the series, the cumulative impact was greater than the individual media. For example, those who experienced both the broadcast and digital media were significantly more familiar with citizen science than those who only watched an episode or only used the website. Those who were exposed to both media also exhibited greater understanding, confidence, positive beliefs about citizen science, and were more actively

engaged in citizen science-related activities than those who only watched the series. Thus, the website and series functioned best together, with the website serving as a portal through which viewers who were motivated by the episodes could connect with citizen science projects and become doers.

The project's robust social media campaign supported both the broadcast series and the website. While the broadcast series and website are platforms that require viewers and users to engage first by watching the series or visiting the website, the project's social media allowed the series producers to push content directly to their followers across multiple platforms, such as Facebook, Twitter, and Instagram. The most effective content tended to include colorful images or video with little to no text, cross-promote citizen science-related events, mention an individual or group affiliated with a citizen science project featured in the series or on the website, have slightly longer character counts, use more hashtags, and be posted in conjunction with the television air dates. In this way, social media extended the reach of the project beyond what the broadcast series or a website could otherwise do.

In sum, The Crowd & The Cloud's broadcast and digital media succeeded in making viewers aware of citizen science initiatives around the world, changed people's perceptions of citizen science, and motivated a new wave of individuals to engage in scientific research to fill in knowledge gaps, track trends using large datasets, or address problems within their local communities.

Appendix A

Unmatched Survey Respondent Demographics

Table 19. Unmatched Survey Respondents' Gender

Gender	Broadcast Only (N=102)	Website Only (N=70)	Website + Broadcast Series (N=229)	Did Not View Series or Go on Website (N=1222)
Male	34	20	82	338
Female	38	39	78	736
Prefer not to answer/ Did not specify	30	11	69	213

Table 20. Unmatched Survey Respondents' Ethnicity

Ethnicity	Broadcast Only (N=102)	Website Only (N=70)	Website + Broadcast Series (N=229)	Did Not View Series or Go on Website (N=1222)
White/Caucasian	60	36	128	846
African American	3	11	9	55
Hispanic	2	4	6	23
Native American	2	2	5	7
Asian	0	2	4	15
Pacific Islander	2	1	1	5
Other	3	4	3	41
Prefer not to answer/ Did not specify	30	10	73	230

Table 21. Unmatched Survey Respondents' Age Range

Age Range	Broadcast Only (N=102)	Website Only (N=70)	Website + Broadcast Series (N=229)	Did Not View Series or Go on Website (N=1222)
Teens	1	1	2	2
20's	11	9	32	31
30's	11	13	55	113
40's	11	8	21	121
50's	6	9	21	193
60's	19	16	26	327
70's	17	7	6	213
80's	1	0	0	37
90's	0	0	1	1
Did not specify	25	7	65	184

Table 22. Unmatched Survey Respondents' Education Levels

Age Range	Broadcast Only (N=102)	Website Only (N=70)	Website + Broadcast Series (N=229)	Did Not View Series or Go on Website (N=1222)
Some high school	1	1	0	5
High school graduate/ GED	4	3	3	32
Some college	8	4	14	107
2 year degree	2	7	11	51
4 year degree	27	23	91	345
Master's degree	27	16	35	355
Professional degree (JD, MD)	4	3	2	68
Doctorate	5	6	7	81
Did not specify	24	7	66	178

Table 23. Unmatched Survey Respondents' Average Social Media Use*

Social Media Platform	Broadcast Only (N=77)	Website Only (N=63)	Website + Broadcast Series (N=164)	Did Not View Series or Go on Website (N=1044)
Facebook	1.14	1.14	1.51	1.30
Twitter	0.66	0.79	1.15	0.49
Instagram	0.53	0.63	0.99	0.38
Medium	0.19	0.30	0.58	0.10
YouTube	1.21	1.32	1.40	1.20

** On a scale from 0 to 2, with 0 = Never used, 1 = Infrequent use (less than once a week), and 2 = Frequent use (once a week or more).*

Table 24. Social Media Platforms That Unmatched Survey Respondents Use to Get Science Information*

Social Media Platform	Broadcast Only (N=102)	Website Only (N=70)	Website + Broadcast Series (N=229)	Did Not View Series or Go on Website (N=1222)
Facebook	19	17	88	284
Twitter	9	13	55	121
Instagram	4	7	25	32
Medium	4	2	6	26
YouTube	23	16	64	255
Other	23	20	31	412
None	6	17	79	436

** Some respondents listed more than one social media platform*

Appendix B

Broadcast Series' Focus Group Demographics

Table 25. Broadcast Series' Focus Group Participants' Gender

Gender	General Public (N=39)	Citizen Science Participants (N=33)	Professional Scientists (N=38)
Male	11	6	15
Female	28	27	23

Table 26. Broadcast Series' Focus Group Participants' Ethnicity

Ethnicity	General Public (N=39)	Citizen Science Participants (N=33)	Professional Scientists (N=38)
White/Caucasian	26	25	22
African American	3	3	1
Hispanic	2	2	1
Native American	1	0	0
Asian	3	3	7
Other	1	0	5
Did not specify	1	0	2

Table 27. Broadcast Series' Focus Group Participants' Age Ranges

Age Range	General Public (N=39)	Citizen Science Participants (N=33)	Professional Scientists (N=38)
18-24	5	2	14
25-34	11	11	12
35-44	7	5	4
45-54	3	3	2
55-64	4	7	4
65-74	4	4	1
75-84	1	0	0
Did not specify	2	1	1

Table 28. Broadcast Series' Focus Group Participants' Education Levels

Education Level	General Public (N=39)	Citizen Science Participants (N=33)	Professional Scientists (N=38)
High school graduate/GED	2	0	0
Some college	4	3	10
2 year degree	5	0	1
4 year degree	10	8	13
Master's degree	12	18	4
Professional degree (JD, MD)	0	1	1
Doctorate	2	2	7
Did not specify	2	1	2

Appendix C

Online Focus Group Demographics

Table 29. Online Focus Group Participants' Gender (N=17)

Gender	Number of Respondents
Male	2
Female	15

Table 30. Online Focus Group Participants' Ethnicity (N=17)

Ethnicity	Number of Respondents
White/Caucasian	10
African American	2
Hispanic	2
Native American	1
Asian	0
Pacific Islander	0
Other	1

Table 31. Online Focus Group Participants' Age Ranges (N=17)

Age Range	Number of Respondents
18-24	1
25-34	7
35-44	3
45-54	2
55-64	2
65-74	2

Table 32. Online Focus Group Participants' Education Levels (N=17)

Education Level	Number of Respondents
Some high school	0
High school graduate/GED	0
Some college	1
2 year degree	1
4 year degree	4
Master's degree	8
Professional degree (JD, MD)	0
Doctorate	3

Table 33. Online Focus Group Participants' Engagement in Scientific Research (N=17)

Category	Number of Respondents
Regularly engage in scientific research	8
Do not regularly engage in scientific research	9

Table 34. Online Focus Group Participants' Previous Participation in Citizen Science Projects (N=17)

Category	Total Number of Respondents
Have previously participated in a citizen science project	5
Have not previously participated in a citizen science project	12

Table 35. Online Focus Group Participants' Social Media Use (N=17)

Social Media Platform	Never Use	Infrequent User	Frequent User (Once a week or more)
Facebook	0	3	14
Twitter	4	8	5
Instagram	7	2	8
Medium	16	1	0
YouTube	0	4	13

Table 36. Social Media Platforms That Online Focus Group Participants Use to Get Their Science Information (N=17)*

Social Media Platform	Number of Respondents
Facebook	10
Twitter	6
Instagram	3
Medium	0
YouTube	10

** Some respondents listed more than one social media platform*

Appendix D

Table 37. Top 10 Referrals to CrowdandCloud.org from Other Websites

Source	Number of Sessions
grist.org	219
alternet.org	186
blogs.worldbank.org	137
pw.myersinfosys.com	84
worldchannel.org	83
brightfocus.org	80
duckduckgo.com	75
outlook.live.com	68
go.davidsuzuki.org	61
citizenscience.org	55

Table 38. Top 10 Citizen Science Projects Participants Joined or Contributed to on SciStarter (March - June 2017)

Projects	Number of Participants Who Joined	Number of Participants Who Contributed
EyesonAlz	27	37,985
Citizen Sort	15	0
Smithsonian Transcription	11	0
NASA GLOBE Observer:	8	0
The Great Backyard Bird Count	7	0
Age Guess	7	0
Global Explorer	6	0
Biomedical Citizen Science	6	0
ISeeChange	5	0
EyeWire	5	0

Table 39. Top 7 Facebook Posts During March - June 2017, Based on Impressions & Engagement

Post	Date Posted	Impressions: Total number of unique people your post reached over the lifetime of the post	Engagement: Unique users who have engaged wth post over the lifetime of the post
Dianna Kane is featured in The Crowd & The Cloud Episode 3: Viral vs. Virus. As the Senior Designer at Medic Mobile, she is a leader in human-centered design and health systems change. She joins us on FB live tonight at 10pmPDT to answer YOUR questions about new technologies and #CitSci! Learn more about Dianna here: https://tinyurl.com/lbm5s8g and watch the Episode 3 premiere tonight at 9pm on WORLD Channel: https://tinyurl.com/kkzxzkf #MedicMobile #CrowdCloudLIVE	4/20/17	22,496	454
Join us! Thursday April 27, watch “Citizens4Earth” on WORLD channel or stream from CrowdAndCloud.org or PBS.org During the show: Follow our live tweets and tweet us your questions via #CrowdCloudLIVE 9pmET and again 9pmPT After the show: Host Waleed Abdalati, show producers, and #CitSci experts will be LIVE on Facebook to answer your questions. 10pm ET and again 10pm PT	4/22/17	14,142	143
Talip Kilic is a Senior Economist for the Living Standards Measurement Study (LSMS) Program at the World Bank Development Data Group. Talip takes us on an engaging tour of rural Uganda on Episode 4, airing this Thursday on WORLD Channel: https://tinyurl.com/kkzxzkf Read about Talip’s work in Africa: https://tinyurl.com/mkd7tme	4/26/17	8,499	759
Join us! Thursday April 13, watch “Citizens + Scientists” on WORLD channel or stream from CrowdAndCloud.org or PBS.org During the show: Follow our live tweets via #CrowdCloudLIVE After the show: Host Waleed Abdalati, show producers, and #CitSci experts will be LIVE on facebook to answer your questions. 10pm EDT and again 10pm PDT	4/10/17	7,961	174
Stephanie Mumma can be seen on The Crowd & The Cloud Episode 4: Citizens4Earth. She is a Research Associate at the Scripps Institution of Oceanography, and the former Project Lead for TheSmartfin--a radical #CitizenScience tech startup. We are looking forward to the Episode 4 premiere on WORLD channel: https://tinyurl.com/kkzxzkf Tune in Thursday, 4/27 at 9pm! #Surfing #Oceans #Earth	4/22/17	5,322	395
"No one should have to lose their memories and we won't stop until #Alzheimer's is just a memory." Watch this must see video of Judy & Steve's #LongestDay2017 here https://www.youtube.com/watch?v=FoVqD6mAVSA! This is what success looks like #EndALZ #CitizenScience	6/20/17	3907	215
Angel and Mariel Abreu are a husband and wife birding duo who run guided tours through their company, Nature is Awesome Birding & Wildlife Tours. They can be seen in The Crowd & The Cloud Episode 4: “Citizens4Earth” airing on WORLD Channel and PBS: https://tinyurl.com/kkzxzkf Read our interview with this dynamic couple here: https://tinyurl.com/lhv7t3j	5/4/17	3201	369

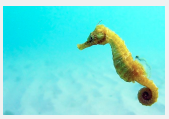
Table 40. Top 16 Facebook Video Posts During March - June 2017

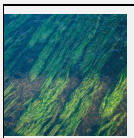
Post	Number of unique people who viewed video for 30 seconds or to the end, whichever came first, over the lifetime of the post	Number of unique people who watched your video at 95% of its length, including people who skipped to this point	Date Posted
Crowd & Cloud: 4/27/17 10pm PT	4667	1	4/27
Crowd & Cloud: 4/27/17 10pm ET	4645	2	4/27
#CrowdCloudLIVE 4/20/17 10pm EDT	3028	1	4/20
The Crowd & Cloud Live Aftershow: April 13 10pm EDT	2700	0	4/13
#CrowdCloudLIVE 4/20/17 - 10pm PDT	2674	1	4/20
The Crowd & Cloud Live Aftershow: April 13 10pm PDT	2487	1	4/13
#CrowdCloudLIVE - Even Big Data Starts Small 10pm ET	268	2	4/6
The "Hope Lap" begins!!!	224	83	6/17
#CrowdCloudLIVE - Even Big Data Starts Small 10pm PDT	158	2	4/6
The world premiere is here! Join us at 9pm ET & PT for the official world premiere of #CrowdAndCloud! Stay with us afterwards for our Facebook Live event at 10pm ET & PT for a chat and Q&A with the #CitizenScientists from the show!	156	157	4/6
Pietro Michelucci from Eyes On ALZ & #StallCatchers on Judy's Longest Day.	119	31	6/17
The Longest Day continues with the Longest Dinner... all advancing Alzheimer's awareness and research.	106	52	6/17
Judy Johanson explains her plans for Watertown's Longest Day and the Hope Lap.	96	57	6/17
The Lap ends but hope continues.	76	56	6/17
#CrushALZ #CroudCloudLIVE Video Chat	69	0	5/10
Want a sneak peek of tonight's episode? Check out the trailer for Episode 1: Even Big Data Starts Small. Watch the full episode tonight on your local PBS station or stream from CrowdAndCloud.org! Follow our live twitter feed, and share your questions using #CrowdCloudLIVE Then, don't forget to join us for the LIVE after-show #citsci chat! Host Waleed Abdalati, show producer Geoff Haines-Stiles, and a GREAT panel of citizen science experts will be on fb live at 10ET and again 10PT to answer your questions! Find your local public tv AIRDATES: http://crowdandcloud.org/watch-the-episodes/episode-one?theHref=airDates	55	61	4/6

Table 41. Top 10 Tweets During March - June 2017

Post	Sum of Retweets and Likes	Date Posted
Skilled birders are often as good or better at identifying birds as professional scientists!" @audubonsociety #CrowdCloudLIVE https://t.co/FlSEhcd4vD	54	4/28
"Hundreds of Thousands of Spiders Sent to Denver Museum, Because Science" | https://t.co/hvkkpkdEkC @DenverMuseumNS @DenverWestword #CitSci	50	6/2
We're 8 days out from the world premiere and we need your help! Go here https://t.co/nLwoWHBGen and share our #ThunderClap! #CitizenScience	46	3/29
Will the next great scientific discovery be made by amateurs? https://t.co/tnuynW84xW #CitizenScience @SmithsonianMag	27	6/30
In Ep 4 Citizens4Earth we meet conservationists capturing data to protect pollinators, butterflies, ; more #CrowdCloudLIVE #CitizenScience https://t.co/XWMYmzdsBR	27	4/27
Coming off of a thrilling night of #CitizenScience; #Community! Check out our FB Live from last night's premiere. https://t.co/gQeZGYeHt1 https://t.co/eUOWdZr7y0	27	4/07
"I Used to Judge Citizen Scientists. Now I Am One." https://t.co/DIjqCnEm92 #CitizenScience	26	5/29
#CitizenScience helps protect our #Oceans! 2 days to the PREMIERE of #CrowdCloud - WATCH on WORLD, PBS, or stream on https://t.co/Jsw8XSGu7y https://t.co/UOHIlNeds3	26	4/5
The day is finally here! Tell everyone, even that neighbor you don't like, to watch tonight and join in on the #CrowdCloudLIVE chat after! https://t.co/PtIaFky5w8	24	4/6
#CitizenScientists map the #earth! See the PREMIERE of #CrowdAndCloud in 3 days on @worldchannelPTV, @PBS, stream on https://t.co/Jsw8XSGu7y https://t.co/k9txiBxWKd	24	4/3

Table 42. Top 10 Instagram Posts During March - June 2017

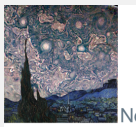
Posts	# of likes	% engagement	Date
 can't be there. However, we bring back up to 400,000 images per year and we just can't keep up! We need your help to classify images so we now which images are the highest priority for biologists to review." || Via http://bit.ly/2mxCTfF #Zooniverse @noaafisheries @noaa #CitizenScience #CitSci #Science #Sciences #Scientist#CitizenScientists #Conservation || #StellarWatch#StellarSeaLions #Alaska #America #USA #Aleutian#AleutianIslands #CrowdSource || #PublicEngagement#Collaboration #Research #Environment #Earth #Climate#Global #CrowdAndCloud #ClimateChange#GlobalWarming #Amazing #Love	182	21%	3/16
 The #SolitaryBee project aims to better understand and protect #Bees! "There are more than 200 species of solitary bee in the U.K. meaning they account for more than 90% of all our bee species. They are so named because, unlike honeybees and bumblebees, they live alone. They vary greatly from their physical appearance to the way they live, making them a truly fascinating group to learn about. They are also very important to us as they help pollinate our crops, trees and wildflowers. Quite little is known about this vast group, particularly compared to their more famous cousins; the bumblebees and honeybee. One part we have very little knowledge about is where they choose to nest and why. By gaining a greater understanding of nesting, we can better inform our land management practices in everything from agriculture to gardening to urban planning. That is the aim of this project." || Via www.thesolitarybeeproject.org @angliaruskin #CitizenScience #CitSci #Science #Sciences #Scientist#Conservation || #AngliaRuskinUniversity #Honey #Bee#Flowers #Pollen #Pollinator #Hobbyist #Climate #Global#ClimateChange #GlobalWarming #Wildlife #Biodiversity#Crowdsource #CrowdAndCloud || #Amazing #Instacool#Instadaily #Instagood #Love	182	17%	4/12
 "Few have witnessed what you're about to see." Isn't that awesome!? "It all started back in July 2007, with a data set made up of a million galaxies imaged by the Sloan Digital Sky Survey, who still provide some of the images in the site today. With so many galaxies, we'd assumed it would take years for visitors to the site to work through them all, but within 24 hours of launch we were stunned to be receiving almost 70,000 classifications an hour. In the end, more than 50 million classifications were received by the project during its first year, contributed by more than 150,000 people." || Via www.galaxyzoo.org #CitizenScience #CitSci #Science #Sciences #Scientist#CitizenScientists #Conservation || #GalaxyZoo #Galaxy#Universe #Cosmos #Zooniverse #Space #OuterSpace#ExoPlanet #Cosmos #SolarSystem #Community#Technology #Hardware #Research #Collaboration#Research || #Earth #Climate #Global #CrowdAndCloud#ClimateChange #GlobalWarming	180	24%	3/3
 "iSeahorse is a tool for seahorse science and conservation. iSeahorse harnesses the power of 'citizen scientists' — anyone, anywhere in the world who sees a seahorse in the wild — to improve our understanding of these animals and protect them from overfishing and other threats." Via www.iseahorse.org@zsllondonzoo @inaturalistorg, Image Credit: bit.ly/2iMx6Vp #CitizenScience #CitSci #Science #Sciences #Scientist#CitizenScientists #Conservation || #ISeaHorse #Seahorse#Overfishing #Ocean #Sea #Underwater#PublicEngagement #Collaboration #Research#Environment #Earth #Climate #Global #CrowdAndCloud#ClimateChange #GlobalWarming #Amazing #Love	178	17%	4/15

Posts	# of likes	% engagement	Date
 On Saturday, March 25 8:30-9:30pm local time, join hundreds of millions of people around the world and turn off your lights for one hour to show your commitment to the planet. Participate in #GlobeAtNight before, during and after #EarthHour. Visit www.globeatnight.org and www.earthhour.org for details. Spread the word! || Via@earthhourofficial @nsfgov @scistarter #CitizenScience #CitSci #CitizenScientist #Science #Sciences #Scientist#Conservation || #Lights #Electricity #Globe #Night #Constellations #Stars #Space#MilkyWay || #Global #Humanity #Human #Hobbyist #Climate #ClimateChange#GlobalWarming #Wildlife #Biodiversity #Crowdsource #Amazing #Love	177	18%	3/23
#CitizenScience + #Suds! Do you live in#LosAngeles? Check out what @timeoutla has to say about this local project by@angelcitybeer & @nhmla "Find out how harnessing the power of people can have a serious impact on science at this beer and lecture series. Each month the Natural History Museum will highlight a different community project, while Angel City Brewery will involve participants in its quest to build the first crowd-sourced beer." || Via http://bit.ly/2mZFMdz & image credit to #AngelCityBrewery #CitSci #Science #Sciences #Scientist#CitizenScientists #Conservation ||#NaturalHistoryMuseum#NaturalHistoryMuseumofLosAngeles #LA#California #Beer #Ale #CraftBrew#CraftBrewery #CrowdSource #Water#Environment #Community #Collaboration#Research || #CrowdAndCloud#ClimateChange #GlobalWarming #Amazing#Love	176	21%	3/8
 Love #Reptiles and #Amphibians? #HerpMapper is for you! "HerpMapper is a not-for-profit cooperative project, designed to gather and share information about reptile and amphibian observations across the planet. Using HerpMapper, you can create records of your herp observations and keep them all in one place. In turn, your data is made available to HerpMapper Partners – groups who use your recorded observations for research, conservation, and preservation purposes. Your observations can make valuable contributions on the behalf of amphibians and reptiles." || Via http://bit.ly/2ls3OJQ #CitizenScience #CitSci #Science #Sciences #Scientist #Conservation || #Map#Maps #PublicGood #Engagment #Neighborhood #Local #Community || #Biology#GlobalWarming #Hobbyist #Habitat #Environment #Biodiversity#CrowdAndCloud || #Amazing #Instacool #Instadaily #Instagood #Love	171	21%	3/2
 Waste not on World Water Day: Bob McDonald We should be saving the pure potable water to drink, then recycle wastewater for everything else" || Via http://bit.ly/2ne1cCR @cbcnews #CitizenScience #CitSci #CitizenScientist #Science#Sciences #Scientist #Conservation || #WorldWaterDay#Water #Recycle #Wastewater #Potable #Potability #CBC#DrinkingWater || #Global #Humanity #Human #Hobbyist#Climate #ClimateChange #GlobalWarming #Wildlife#Biodiversity #Crowdsource || #Amazing #Instacool#Instadaily #Instagood #Love	168	17%	3/22
 "Seagrass Spotter is a conservation and education tool for tracking seagrass meadows around the globe. Help us conserve our coastline by uploading your own seagrass sightings." || Via www.SeagrassSpotter.org @projectseagrass #CitizenScience #CitSci #CitizenScientist #Science #Sciences #Scientist#Conservation || #Seagrass #SeagrassSpotter #Ocean #Waterways #TeamSeagrass|| #Hobbyist #Climate #ClimateChange #GlobalWarming #Wildlife #Biodiversity#Crowdsource #Amazing #Love	167	16%	3/27

Posts	# of likes	% engagement	Date
 #CitizenScience isn't done for congratulations, but it can be nice to be recognized for work well done! Glenn Dennison was honoured by the Coastal Ocean Awards for his work studying Howe Sound's precious glass sponge reefs. Read more here! http://bit.ly/2mPend4 @NorthShoreNews #CitSci #Science #Sciences #Scientist#CitizenScientists #Conservation || #Ocean#Water #GlassSpongeReef #Reef#HoweSound #CoastalOceanAwards ||#PublicEngagement #Collaboration #Research#Environment #Earth #Climate #Global#CrowdAndCloud #ClimateChange#GlobalWarming	166	18%	3/15

Table 43. Instagram Posts with the Highest Overall Daily Growth in Followers During March - June 2017

Posts	# of followers added	Date Posted
 "Seagrass Spotter is a conservation and education tool for tracking seagrass meadows around the globe. Help us conserve our coastline by uploading your own seagrass sightings." || Via www.SeagrassSpotter.org @projectseagrass #CitizenScience #CitSci #CitizenScientist #Science #Sciences #Scientist#Conservation || #Seagrass #SeagrassSpotter #Ocean #Waterways #TeamSeagrass|| #Hobbyist #Climate #ClimateChange #GlobalWarming #Wildlife #Biodiversity#Crowdsource #Amazing #Love	20	3/27
 On Saturday, March 25 8:30-9:30pm local time, join hundreds of millions of people around the world and turn off your lights for one hour to show your commitment to the planet. Participate in #GlobeAtNight before, during and after #EarthHour. Visit www.globeatnight.org and www.earthhour.org for details. Spread the word! || Via@earthhourofficial @nsfgov @scistarter #CitizenScience #CitSci #CitizenScientist #Science #Sciences #Scientist#Conservation || #Lights #Electricity #Globe #Night #Constellations #Stars #Space#MilkyWay || #Global #Humanity #Human #Hobbyist #Climate #ClimateChange#GlobalWarming #Wildlife #Biodiversity #Crowdsource #Amazing #Love	19	3/23

Posts	# of followers added	Date Posted
 Love #Reptiles and #Amphibians? #HerpMapper is for you! "HerpMapper is a not-for-profit cooperative project, designed to gather and share information about reptile and amphibian observations across the planet. Using HerpMapper, you can create records of your herp observations and keep them all in one place. In turn, your data is made available to HerpMapper Partners – groups who use your recorded observations for research, conservation, and preservation purposes. Your observations can make valuable contributions on the behalf of amphibians and reptiles." || Via http://bit.ly/2ls3OJQ #CitizenScience #CitSci #Science #Sciences #Scientist #Conservation || #Map#Maps #PublicGood #Engagment #Neighborhood #Local #Community || #Biology#GlobalWarming #Hobbyist #Habitat #Environment #Biodiversity#CrowdAndCloud || #Amazing #Instacool #Instadaily #Instagood #Love	16	3/2
 New Jupiter Images: Do You See Cotton Candy or Van Gogh's 'Starry Night'? || Via http://bit.ly/2mlH9SJ @spacedotcom #CitizenScience #CitSci #Science #Sciences #Scientist #CitizenScientists#Conservation || #Jupiter #SpaceDotCom #NASA #Galaxy #Universe #Cosmos#Space #OuterSpace #Cosmos #SolarSystem #Community #Technology#Hardware #Research #Collaboration #Research || #Earth #Climate #Global#CrowdAndCloud #ClimateChange #GlobalWarming	15	3/7
 can't be there. However, we bring back up to 400,000 images per year and we just can't keep up! We need your help to classify images so we now which images are the highest priority for biologists to review." || Via http://bit.ly/2mxCTfF #Zooniverse @noaafisheries @noaa #CitizenScience #CitSci #Science #Sciences #Scientist#CitizenScientists #Conservation || #StellarWatch#StellarSeaLions #Alaska #America #USA #Aleutian#AleutianIslands #CrowdSource || #PublicEngagement#Collaboration #Research #Environment #Earth #Climate#Global #CrowdAndCloud #ClimateChange#GlobalWarming #Amazing #Love	15	3/16