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Science Engagement via Twitter: Examining the Educational Outreach of Museums, Zoos, Aquariums and Other Science Organizations

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ABSTRACT

Many science museums and wildlife attractions use social media as a marketing tool to encourage visitors. However, our survey research on Twitter and museums, zoos, and other science institutions finds that there are 2 groups of people following these organizations to learn about science. The informed citizens follow trusted science organizations on Twitter to learn about the science. The other public, the science communicators, follow these organizations to stay current on scientific news and advances, but they are also deeply interested in sharing scientific news via Twitter and in being part of a larger social conversation about science. Both of these publics are interested in staying current in science, but the communicators also offer these organizations a channel to communicate science to a broader public.

Social media are rapidly transforming the nature of public discourse and the ways in which adults learn about the changing world around us. This, of course, is affecting the public discourse about science and how people learn about science. In the past, large-scale educational outreach and dissemination of science information was the preserve of organizations primarily focused on producing high-quality informational content about science for widespread dissemination, such as NOVA, *Scientific American*, or *National Geographic*. However, the lower production costs, the ease of dissemination, and the short-form nature of Twitter content or of a blog post mean that many other science institutions can now educate, share, and engage with the public in ways that do not require a large production department. Yet little research has been done on how the public interacts with science organizations through social media. With support from the National Science Foundation, we developed and administered a survey to the Twitter followers of various science organizations to understand their goals, motivations, and expectations for participating in public science discourse using social media tools such as Twitter.

Because the goal of our work was to explore the role of social media as an educational outreach channel for science organizations that are not science media organizations, we sought to collaborate with highly respected science institutions or government agencies that are not already sponsoring broadcast events, major publications, or other public education activities that reach into people's homes and private lives via

“traditional media.” Therefore, we are not looking at institutions such as NOVA or *Scientific American*. Instead, we identified institutions that are using social media to develop new outreach capacities, and ultimately selected three types of institutions to focus on: science museums, wildlife education societies, and government science agencies. For this study, we surveyed Twitter followers of four science organizations: a large natural history museum in the Northeast, a big city zoo in the Midwest, and two federal science agencies—National Aeronautics and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA).

Findings from our survey suggest that there are two distinct publics that are interested in science that are following science organizations on Twitter. Both groups expressed interest in staying informed about science and look to these organizations for relevant science information, but one public is particularly interested in engaging with a broader science community by retweeting and sharing science information. These differences might inform how these science organizations use Twitter (and other social media) to further their educational mission.

Twitter and science communication

The Internet and social media are playing an increasingly large role in informing the public about science. By 2010, the Internet had surpassed TV as Americans’ source for information on science, according to Science and Engineering Indicators for 2014 (National Science Board, 2014). That study shows that 42% of Americans say they look online for news about science, whereas only 32% reported turning to TV for science information. To learn about specific science topics, 63% of Americans go online (National Science Board, 2014). But the role of social media within this space is unclear and underresearched, although it is certainly growing. Outside of the health field, a review of the research on Twitter conducted in 2013 found almost no articles on Twitter in relation to science (Williams, Terras, & Warwick, 2013). Since that time, researchers like Sara Yeo (Yeo, Cacciatore, Brossard, Scheufele & Xenos 2014; Runge et al., 2013) have started exploring how scientists are using Twitter to connect to the public.

More recently a team of scholars at the University of Zurich (Eszter Hargittai, Tobais Füchslin, and Mike Schäfer) have started exploring how the general public uses social media to engage with science suggesting that there is an active audience for science information (Hargittai, Füchslin, & Schäfer, 2018; Schäfer, Füchslin, Metag, Kristiansen, & Rauchfleisch, 2018). For example, their survey study on young adults in the United States found that the respondents turn to the Internet for science information as frequently as they look for health information or celebrity news (62.9%, 61.9%, and 63.7%, respectively, do this weekly).

The research on information seeking on Twitter more broadly finds the 63% of Twitter users get news about events and issues on Twitter (Mitchell & Guskin, 2015). Other research about Twitter users’ intentions divides users into three groups: (a) information sources who attract followers because of their updates; (b) friends who are on Twitter to connect with friends and family; and (c) information seekers who use Twitter to collect information. None of this research is focused specifically on science or science institutions, but it stands to reason that similar trends apply.

Though most U.S. scientific institutions and government agencies have Twitter feeds, Pinterest accounts, and Facebook pages, they often view social media more as a marketing tool than as part of the public discourse on science or as part of informal learning (Langa 2014; Regenber, 2010; Suzić, Karlíček, & Stríteský, 2016). Increasingly, there are calls from scientists for the science community to use social media to engage and educate the public about their research and about science in general (Osterrieder, 2013; Regenber, 2010; White, 2013). However, previous studies highlight potential risks for museums and similar institutions of using new outreach channels without fully understanding the interaction dynamics between the institution and the public (Kidd, 2011; Langa, 2014; Suzić, Karlíček & Stríteský, 2016). Social media strategies can be ineffective, if not counter-productive, when not well thought out. One goal of this study was to begin to explore Twitter followers' motivations and intent in following science organizations.

Methodology

The overall goal of the study was to explore the goals, motivations, and expectations that users have when participating in public science discourse using social media tools such as Twitter. To ensure the validity of the instrument, we used an iterative design approach that captured input from relevant literature, the target population, and our own expertise.

Selecting the sample

There are a variety of presences on Twitter that are about science. Science media organizations like *National Geographic*, NOVA, or *Scientific American* are very active in tweeting about science. There are also well-known scientists and science advocates such as Neil deGrasse Tyson or Bill Nye the Science Guy who have an active Twitter presence and large followings. Advocacy groups and scientific societies like the Audubon Society or the World Wildlife Fund, are on social media. The different types of organizations that do science are present on Twitter: University-based research centers, such as the Cornell Lab of Ornithology; or government science agencies like NASA or NOAA. NASA, for example, has over 27 million followers. Also, there are science organizations like museums, aquariums, wildlife or zoological parks, or botanic gardens that are active on Twitter.

For this study, we wanted to survey the followers of organizations that are part of the average citizens' life, that do science but do not have large production budgets for science-media. Many science and natural history museums have a corps of scientists who are actively engaged in research. For these museums, the origins of their public collections were the byproduct of field research. Also, the larger zoos and aquariums support research in many fields (i.e., conservation, zoology animal health) and have research scientists on staff. These science institutions have on-site educational activities, but do not necessarily have a large media presence. The research sought to establish whether types of organizations that have distinct physical presences also have a social media following of citizens interested in science.

Government agencies, such as NASA or NOAA, have large teams of scientists actively engaged in research. Although they do not have physical sites for people to visit like a

museum does, they are part of the average citizen's life. Because anyone interested in space or climate issues is probably aware of these two agencies in particular, the research also sought to explore whether these agencies have a social media following interested in science information and updates.

Because Twitter streams are public communication, we could have, in theory, worked with the stream of any informal learning institution. However, we wanted to collaborate with different science organizations and seek their support in surveying their followers. In the end, we collaborated with NOAA, a large natural history museum in the Northeast, and a large Midwestern zoo.

Designing the survey

The survey was developed over four phases: In Phase 1, we developed a preliminary set of survey constructs about informal science learning, goals, motivations, and expectations for using social media in general, and Twitter more specifically. These constructs are based on existing literature, a content analysis of a sample of tweets, and consultation with experts from our collaborating institutions. We then conducted open-ended ethnographic telephone interviews with followers of these science institutions on Twitter. These interviews provided insight into the ways the target population understands and thinks about engaging with science on Twitter, as well as the language they use to discuss the topic. After a systematic analysis of the interviews, we revised our constructs and developed initial survey items for each construct. These items were reviewed by a member of our advisory board with expertise in survey design, and with our colleagues at EDC with expertise in science, social media, and informal learning. In Phase 2, we conducted two rounds of structured cognitive interviews with followers of the natural history museum, the zoo, and NASA on Twitter using the survey. These interviews confirmed that the survey's language, terminology, and response categories were meaningful and comprehensible to the target population. We revised the survey between the two rounds of interviews. During Phase 3, we piloted the survey in the Twitter streams of two science organizations—NASA and the Midwestern Zoo—and used the data to compute item-level statistics and to identify problematic items. After these initial survey rounds, we modified the instrument and created a final version. The final survey is tailored to each institution and relevant items asked respondents' perceptions about that specific institution. In Phase 4, we administered the final survey to new samples of Twitter followers for these institutions.

Constructs

We developed the survey around the following constructs relevant to understanding people's engagement with science via Twitter.

- *Motivation for following science on Twitter:* Following an organization on Twitter is a conscious act that could be driven by many motives. Previous research around Twitter in other domains finds that users have various intentions; some users want to share information, others might want to connect with friends or others might be looking for information (Java, Song, Finin, & Tseng, 2007; Holmberg, Bastubacka, & Thelwall, 2016). We

know from our interviews with Twitter followers that there are a range of possible motives. For example, one man followed a natural history museum because he is interested in science, but also had fond memories of childhood visits to that particular museum, which was why he followed it. Therefore, we created a scale of 11 items focused specifically on science-related motives that we broke down into three aspects: desire to stay informed about science (three items); desire to participate in science community or public conversation on social media (five items); desire to share information (one item); and desire to learn about events or activities at this science institution (two items).

- *Trust in science institution:* Trust is a particularly important variable for two reasons. First, in science, much of the public lacks the background knowledge to fully vet new science knowledge and practices. Within this context, respected science institutions can play a substantial role informing the public and encouraging changes in behavior (Winter & Cvetkovich, 2010). Americans have confidence in their scientific community: In 2012, 41% of Americans expressed “a great deal of confidence” in leaders of the scientific community, and nearly half (49%) expressed “some confidence” (National Science Board, 2014). Second, as trust in the media declines research suggests that the public is increasingly turning to “trusted figures” on social media for news and information (Wynne, 2006; Turcotte, York, Irving, Scholl, & Pingree, 2015). These survey items ask respondents their level of trust in each institution as science organization and how important the institution is to them.
- *Interest in forms of content related to science:* At the time of the research, a tweet was limited to 140 characters but could contain different non-text elements that represent other types of—a photo or drawing, a graph or chart, a link to website or video—or it could be part of a hashtag (#) conversation. To better understand whether respondents are interested in image content as well as the text and if they used tweets as a conduit to other science information, these survey items assess respondents’ interest in different science-related components of a tweet—photos, videos, charts and graphs, or hashtag (#) conversations about science.
- *Personal science information environment:* Our survey asked about one specific source of science information, but we also wanted to know if they had a larger information ecosystem to stay informed about science. People learn from many sources and, outside of school, active learners build their own learning ecologies by weaving together many sources of information or ways to stay engaged (Barron, 2006; Bell, Lewenstein, Shouse, & Feder, 2009). To understand their broader ecology, the survey looked at both Twitter-based sources of science information and other sources such as books, magazines, or television.
- *Attitudes toward science:* The Attitudes Towards Organized Science Scale (ATOSS) was developed by the National Science Foundation to measure public attitudes about the importance and value of science (Brossard, Lewenstein, & Bonney, 2005). The nationally representative results have been reported since the 1990’s in the Science and Engineering Indicators (e.g. National Science Board, 2014).
- *Uses of Twitter:* Because intentions and actions are often connected, the survey asks about how people use Twitter to create and send tweets related to science.

Survey administration

We tailored a version of the survey for each institution and links to the surveys were tweeted out to followers of each institution. Because we did not have a collaborator at NASA, we tweeted out invitations to the survey from our Twitter account, but the other organizations tweeted the invitation from their Twitter accounts. The tweets inviting people to take the survey contained a link to the survey, always referred to science or learning, and offered a chance to win an incentive. Sample invites are “Are you

interested in zoology and science? Win \$25 gift card—take quick survey about science, zoos and Twitter <https://go.edc.org/secret...>” or “Follow #NOAA and #climate on social media? Take this survey about science and Twitter.” Although it varied for each organization, invites were tweeted out two or three times a day over the data collection periods of 7 to 10 days. Most survey responses came within an hour of the invitations being sent out. The studies were conducted between April 2015 and February 2016.

Survey responses for each institution

The lowest number of responses was for NASA perhaps because the survey link was not sent out from a NASA-connected account. The museum and the zoo which sent out invitations from their account had a considerably higher number of responses.

Cluster analysis to segment Twitter users

We used TwoStep cluster analysis in SPSS (version 24) to explore patterns in the data and segment this population of Twitter users based on their responses to 11 items on their motivations for following science institutions on Twitter. Because the bank of 11 items has items connected to four aspects of motivations (information seeking, information sharing, participation, and learning about events), we selected TwoStep cluster method because it allows the program to determine the number of clusters that best fits the data and the TwoStep procedure can work with categorical variables.

The motivational index asked respondents about the importance of 11 different reasons to follow science on Twitter. Responses ranged from *not important* to *extremely important*. Of 399 responses, 372 respondents completed all items on the survey. The estimated Cronbach alpha reliability for the overall sample was .88. The analysis clustered the respondents into two groups of relatively equal sizes—170 users in one group and 202 in the other (see Table 2). These clusters appear to represent two distinct publics following science on Twitter that share an interest being informed about science topics and events, but differ on the importance of a very key aspect of social media—communicating and sharing.

Comparing the two publics

One public, the informed citizens, are interested in science and want to stay informed about science. Their primary reasons are to satisfy their curiosity (70.3%), to learn about specific topics (67.3%) or general science interest (60.9%). They indicate very little interest in any of the more social aspects of social media – they do not want to be part of Twitter conversations about science. For example, 37.7% of informed citizens use Twitter to stay informed about controversial science topics, but only 1% want to participate in conversations about such topics.

Science communicators, the other public, is perhaps at the heart of the emerging social media world—they seem to be actively gathering and sharing information. This public also reports being very interested in science; however, they want to be part of larger scientific conversations and are more active in creating tweets. They see Twitter as one way to stay informed: over 95% feel Twitter is an important way to stay

Table 1. Survey responses for each institution.

Institution	Completed responses
Midwest zoo	213
Northeast natural history museum	110
NOAA	39
NASA	10
Total	372

Table 2. Important reasons for following science on Twitter (percent of respondents marking very or extremely important).

How important to you are the following reasons for following science on Twitter?	Science communicators (<i>n</i> = 170)	Informed citizens (<i>n</i> = 202)
Learn about specific science topics I'm interested in	95.3%	67.3%
Satisfy my curiosity about the world	95.2%	70.3%
Learn about general science topics in the news	92.9%	60.9%
Connect with science experts	91.8%	9.4%
Connect with other people interested in science	85.9%	6.9%
Follow controversial science topics	85.8%	37.7%
Learn about events and/or exhibitions that I can go to	81.2%	59%
Participate in conversations about science	77.6%	3%
Share science content with my followers	77.1%	12.4%
Participate in conversations about controversial science topics	67.7%	1%
Learn about educational resources and/or activities for kids	62.8%	42.1%

informed about science and a way to satisfy their curiosity. However, the communicators want to share and participate in science: 91.8% want to connect to science experts via Twitter, 85% connect with other science enthusiasts or follow controversial science topics. The science communicators are using Twitter to stay informed and to connect to others about science.

Distribution across the science organizations

The overall the respondents broke down into 46% being science communicators and 54% being in the informed citizens public. This suggests that even though the more passive science-interested public (informed citizens) is larger, the portion of science communicators is still substantial. This breakdown also held essentially constant across all three categories of science organizations included in the study. For example, 47% of the zoo's respondents reported being active science communicators.

Differences between science communicators and informed citizens

The current sample does not offer much variation in terms of race and ethnicity because 77% of the sample identify as White, but there are interesting differences regarding age, gender, and education, as well as science-related employment.

Demographic differences

Women make up a larger share of the sample at 66%, and only 34% identified as male. But the division between science communicators and informed citizens within each gender was not equal (see Table 3). Male respondents were evenly split between science

Table 3. Percent of each public following each type of science organization.

Public	Midwest zoo	Northeast natural history museum	Government science agency	Overall
Science communicators (<i>n</i> = 170)	47%	41%	49%	46%
Informed citizens (<i>n</i> = 202)	53%	59%	51%	54%
Total <i>N</i>	213	110	49	372

Table 4. Gender of respondents in each group.

Gender	Science communicators (<i>n</i> = 153)	Informed citizens (<i>n</i> = 178)
Female (<i>n</i> = 219)	45%	55%
Male (<i>n</i> = 112)	49%	51%

communicators (49%) and informed citizens (51%), but female respondents were more likely to be informed citizens (55%) than science communicators (45%).

People in the science communicators group tend to be younger than the informed citizens (see Table 4), which perhaps reflects younger people’s deeper involvement and comfort in sharing and communicating via social media: 16.4% of the communicators are between 18 and 24 and another 31.4% are under 34. The informed citizens skew older with combined number of 34.2% under 34 and the largest share (32.5%) is 35 to 44.

Both groups are relatively well-educated (see Table 9), but a higher percentage of science communicators reported having completed college—48.8% compared to 36.4% for the informed citizens.

Different professional connections to science

About a quarter (27.6%) of science communicators work in a science-related field. Their passion for science and to learn and share about science may reflect their career choices. Given the types of specialized training required for many science-related jobs, the higher share of respondents who have university degrees is not surprising. This finding also mirrors Yeo’s research (Yeo et al., 2014) that many scientists have turned to Twitter to reach out to the public about science.

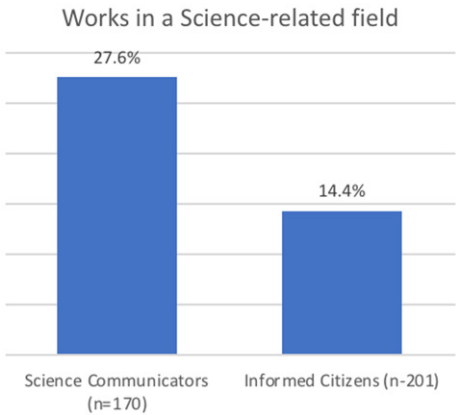


Figure 1. Percent of respondents working in science-related fields.

Table 5. Age of respondents in each group.

Age	Science communicators (n = 140)	Informed citizens (n = 169)
Under 18	.7%	2.4%
18 to 24 years	16.4%	8.3%
25 to 34 years	31.4%	22.5%
35 to 44 years	30%	32.5%
45 to 54 years	15.7%	19.5%
55 to 64 years	5%	8.9%
65 years and over	.7%	5.9%

Table 6. Respondents' level of education in each group.

Education level	Science communicators (n = 164)	Informed citizens (n = 187)
Less than high school	0	2.1%
High school/GED	3%	8%
Some college	11%	17.1%
Bachelor's or associate's degree	48.8%	36.4%
Advanced degree	34.8%	33.7%
Other	1.8%	.5%

Table 7. Percent of respondents very interested in the following Tweeted content.

Content	Science communicators (n = 170)	Informed citizens (n = 201)
Science-related photographs	80%	61.7%
Science-related videos	57.1%	23.6%
Science-related charts, graphs, or info-graphics	50.6%	33.2%
Hashtag (#) conversations about Science	45.9%	7.5%

Table 8. Percent of respondents daily/weekly creating general science content.

Twitter activities	Science communicators (n = 170)	Informed citizens (n = 201)
Retweet a science organization's tweet	75.9%	20.5%
Write a tweet about science	53.5%	10.5%
Comment on a tweet from a science organization/related to science	50.3%	5.5%
Write a tweet for a hashtag (#) conversation about science	45.3%	.5%

Table 9. Number of Twitter followers for each group.

Followers	Science communicators (n = 161)	Informed citizens (n = 186)
No followers	.6%	3.2%
1–100 followers	33.5%	58.6%
101–250 followers	17.4%	21%
251–500 followers	33.5%	7.5%
More than 500 followers	14.3%	8.6%

Interest in tweeted science content

The survey explored other aspects of people's use of Twitter. We found a similar frequency of checking or reading their Twitter accounts for both groups, but differences across a number of other dimensions related to what they are interested in and how they use Twitter. On the survey, 86% and 87%, respectively, of the science communicators and the informed citizens reported using Twitter daily. Differences between the two groups lie in how they use Twitter to engage in science.

A tweet can contain more than just text, it can contain other types of information such as an image, a video, or a chart. A tweet can also carry a link to something on the Web. The survey suggests noticeable differences in what science communicators like in science-based tweets.

First, the survey asked how likely people were to click on a link sent in a science-related tweet (See [Figure 2](#)). Nearly half (48.8%) of the science communicators reported they were very likely to click a link they thought was about science, whereas only 11.4% of the informed citizen said they would be very likely to click on a link. For the science communicators, this may reflect their underlying motivation, which is to be part of a science conversation. Thus, they might be more likely to, or more interested, in following the conversation beyond the tweet.

The survey also asked about interest in different components of a tweet. The science communicators marked the highest degree of interest, “very interested,” in more of the possible components, for example 80% are very interested in science-related photos and 57% in science videos. The informed citizens are most interested in photos as well, but their interest in charts or videos is much less. However, the biggest difference is around the interest in hashtag (#) conversations. Again, this is a reflection of the different underlying motivations since 45.9% of science communicators are interested in hashtag (#) conversations and only 7.9% of the informed citizens express being very interested in hashtag (#) conversations.

Creating science content on Twitter

There are a few ways that content can be created or spread on Twitter. The easiest way to create content is to retweet something to one’s followers, but users can also write a new tweet or comment on a tweet. The science communicators are much more likely to create, comment, or retweet science material and be part of this conversation. [Table 4](#) shows the percentage of each group that reported generating content daily or weekly. For example, 75.9% of the science communicators report frequently doing the simple step of retweeting science tweets to their followers, compared to just 20.5% of the informed citizens. The communicators are also more likely to write a tweet about science and 45.3% are frequently join in a hashtag conversation.

A final important aspect of their Twitter use is the number of followers each respondent reports. There is a notable difference between these two science-interested publics in the number of followers (see [Table 5](#)). The science communicators have larger numbers of followers than the informed citizens: 33.5% of the communicators report having 250 to 500 followers, compared to only 7.5% of the informed citizens. Considering that the science communicators are actively interested in being part of a science conversation on social media, it is not surprising they have also cultivated larger followings.

Discussion

Twitter, like other social media platforms, is a way for institutions to reach out to the broad public, and people probably follow these organizations for a diversity of reasons, many of which have nothing to do with science. However, these survey results clearly

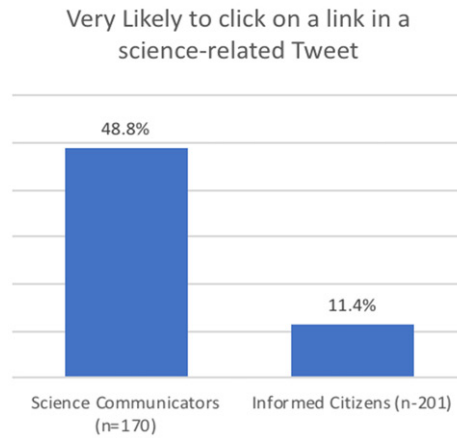


Figure 2. Percent of Followers who are very likely to click through on a science Tweet.

establish that within all the people following these science institutions on Twitter there is a group of followers interested in science and being informed about science topics. However, this group itself breaks down into two publics: informed citizens and science communicators. These two groups report using Twitter equally and both are interested in science, but they have very different motivations for following these science institutions and they also use the information differently.

Informed citizens are Twitter users who are interested in science and see these organizations as a respected institution for science. They report similar levels of reading tweets or checking their feeds as the other group, but they seldom tweet themselves. Their primary motivation for following @NASA or @zoo is to stay informed about science and find out about activities. Members of this public tends to be a little older than the science communicators and they also have fewer followers on Twitter.

Science communicators are perhaps at the heart of the emerging social media world – they seem to be actively gathering and sharing information. These people report being very interested in science but they want to be part of larger scientific conversations and are more active in creating tweets. Nearly all of these followers are following science institutions to learn about science topics they are interested in. They see Twitter as one way to stay informed. However, the communicators also want to share and participate in science: 75.9% report frequently retweeting science tweets and 53.5% report frequently writing science tweets. The communicators trend younger than the informed citizens, and they have more followers (47.8% have 250 or more followers). About a quarter of this public works in a science-related job.

There are a number of considerations for science organizations that grow out of these findings. First, there are clearly two publics that are proactive in learning about and staying up-to-date on various science topics which calls into question standard science communication approaches that assume an uninterested or uninformed public (Hargittai et al., 2018). When crafting a social media plan, science organizations should move beyond just using Twitter to publicize events or raise awareness to author tweets richer in science content to engage and educate an informed audience, as well. For

example, half of the science communicators like tweets with such complex content as charts and graphs.

Second, engaging with these publics via Twitter may be a way for science organizations to amplify their public impact and enrich the larger social conversation about science. The science communicators, in particular, have large followings and are actively engaged in sharing and disseminating about science to their followers. These peer-to-peer friend networks are a way for each science organization to raise awareness of the work they do and the issue they care about. But, the use of social media by the public to share and talk about science and scientific evidence raises a possibility that merits further research. These networks may offer a strategy to introduce science, scientific thinking and evidence into larger social conversations (such as public responses to the consequences of climate change) that are often clouded by opinions and misinformation. For example, because research suggests that people are more likely to change their opinions based on what they learn from people they know (Leiserowitz, Maibach, Roser-Renouf, Howe, & Feinberg, 2012) it might be worth exploring whether and how science organizations can leverage social media to help followers to influence their own networks in ways that support more science-informed discussions.

Finally, science organizations should probably think carefully about their own metrics for measuring a successful social media plan. Science organizations should assume that they are reaching multiple publics who want different content and social media content popular with one group may not be popular with others. These science-engaged publics may be only a small part of each organizations' Twitter following and the most popular or most retweeted posts may not be the posts of interest to the science communicators or the informed citizens. Therefore, setting targets that are simply looking for the highest number of likes or retweets might lead organizations to undervalue and underserve important audiences. However, further research should be done to segment the larger population of people following each organization to better understand the composition and portions of the different publics following each organization.

Conclusion

It difficult to estimate what portion of any science institution's Twitter following is made up of these science-related publics. Although these may be relatively smaller groups within any organizations following, it is important for these science institutions' social media strategies to meet the needs and interests of these two groups. The connection to the group of science communicators, in particular, might open up another channel for education and outreach to fulfill an educational and science outreach mission. These findings suggest that any public science institution can move beyond just thinking of the public as a visitor. Many institutions may already have a cadre of followers who are interested in science generally or other scientific topics relevant to their work and mission. These followers are interested in learning more about science and engaging in conversations about science. Supporting these followers' continued learning helps them become better informed citizens and opinion leaders in their communities. Furthermore, as communicators, these people open up a conduit to their followers.

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