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## The Multipurpose Tool of Social Media: Applications for Scientists, Science Communicators, and Educators

*Julie M. Wolf, Ph.D., American Society for Microbiology, Washington, D.C.*

### Abstract

Social media has become the fastest way to disseminate new information, share personal experiences, and discuss scientific reports in an open-access setting. It acts as an aggregator of news and reports, a platform for education, a means of public outreach, and a tool for scientific research. Each social media service offers unique communication benefits. This review discusses how scientists are using social media to inform and learn from social media communities, concentrating on microbiology and infectious disease.

### Introduction

The term “social media” describes any of a number of networks, hosted through the Internet, that allow interaction between network members. The value of the network is in its breadth and the ability of users to assemble large communities with members from distant locales that would otherwise not be able to interact. In that sense, social media serves us like an international, all-access water cooler. Certainly, most readers are likely familiar with social media websites such as Facebook, Twitter, and Instagram. These websites allow posts within designated parameters that can be hosted and shared by user accounts. LinkedIn, Tumblr, and Snapchat (currently only a smartphone app) are additional platforms, and each outlet varies in its content, focus, ability to add images or links, and character limits.

There are social aspects of communities formed around Reddit and other forums that promote sharing and discussion among users. These communities include the targeted Clinical Microbiology Network (clinmicronet), which allows users (primarily doctoral-level scientists who are clinical microbiologists) to pose questions to the group at large, and respondents can self-select based on their expertise, time, and

willingness. The American Society for Microbiology hosts clinmicronet and divC, a similar site for both doctoral- and non-doctoral-level clinical microbiologists). Reddit communities, known as subreddits, include r/microbiology and r/medlabprofessionals, among other science-oriented subreddits, and are used to pose questions, notifications, and observations related to their titles. However, these forums differ from above-mentioned platforms in that users do not maintain an active individual feed, access is exclusive rather than open, or both. This article focuses on social media that allow universal access and in which individual users curate a home page (also called a wall), as well as interact with other users.

The reasons to use social media vary among users, and these reasons partially determine the level of user activity. The passive user utilizes social media feeds to aggregate news, both by following news outlets directly and by seeing items shared within one’s social network. A 2016 Pew Research Study shows that 62% of American adults get news from social media, up from 49% in a 2012 study [1]. Subscribing to scientific journal feeds, society feeds, and science journalists provides up-to-date information on the latest conference, education, and research publication

Corresponding author: Julie M. Wolf, Ph.D., American Society for Microbiology, 1752 N Street NW, Washington, DC 20036. Tel.: 202-737-3600. E-mail: [jwolf@asmusa.org](mailto:jwolf@asmusa.org)

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news. The active user posts his or her ideas, articles of interest, or responses to other users for a variety of reasons. The type of activity is often dictated in part by the format of the platform.

### Structure Dictates Function: Different Social Media Platform Styles

Each social media platform (in this case, application or website for interaction) varies in its ease of link sharing, image uploading, and character limits. These characteristics reach different audiences and convey different types of information.

The most widely known and used social media platform by far is Facebook: 79% of online Americans have an account, and 76% of those with accounts check in daily [2]. Personal accounts represent the individual, who can form networks with other individuals, requiring both parties to mutually agree to “friend” one another; most scientists use Facebook for personal communication and to share science with friends and family [3]. Not only does Facebook have the highest proportion of American adult users, it also has the highest proportion who use the site for news (44% of adults) [4]. For this reason, many professional outlets maintain an active Facebook fan page. Fan pages differ from personal accounts in that individual users can like/follow a fan page unidirectionally to receive updates from that account without being followed by the fan page.

Fan pages allow all interested individuals to learn about a topic or organization. While the American Society for Microbiology has 47,000 worldwide members, its active Facebook fan page reaches over 280,000, drawing a much broader audience than its membership [5]. Followers learn microbiology facts; view images from ASM's annual Agar Art contest; and receive links to books, reports, and blogs on microbiology topics. The page is also a major source of news about ASM events, resources, and opportunities. ASM uses the large reach of its Facebook site to promote upcoming conferences, journal publications, and fellowship availability. These promotions are an effective way to engage an audience: social media, especially Facebook, can promote continuing medical education options more effectively than email [6].

Many ASM Facebook fan posts lead readers away from Facebook, where they can read a blog post, sign up for a conference, or submit a fellowship application. However, the community on Facebook is also engaged with the content on the fan page. Followers comment or ask questions about the scientific content of posts, and these questions are often answered by other fans. A popular Facebook post in 2016, titled “Assessing Gram Stain Error Rates,” promoted a blog about a *Journal of Clinical Microbiology* article [7] reporting a higher-than-expected error rate among clinical microbiology laboratories. The post was widely shared and commented on by microbiologists of all training levels. The topic popularity was in part due to the ubiquity of the technique among all levels of microbiologists, as students, technicians/technologists, and researchers are familiar with the protocol. This accessibility is important to engage a wide audience; introductory microbiology students are unlikely to be ASM members, but their experience

with the Gram stain during laboratory courses allows them to feel part of the community.

Instagram is one of the most visually appealing platforms, originally based entirely on images during its launch in 2010 and expanding to video in 2013. Each image or video is accompanied by a caption, and hashtags are often used to guide people to key search words. Captions have 2,200-character limits but require the reader to “open” the caption beyond the first three lines.

The compelling images of Instagram make it a great platform for educational outreach. New York University graduate student Sally Warring posts videos at @pondlife\_pondlife of microscopy images taken from water samples near her New York City neighborhood [8]. Each image or short video taken with her iPhone is accompanied by a short description of the world of diatoms, algae, and dinoflagellates. With a following of over 45,000, Warring attracts many people by the images and the short stories she tells about her microbes, which allows her to teach an international audience about environmental microbes.

Instagram typically has less user engagement than Facebook, in that there is less commentary discussion on most images. Many followers “like” a post, but very few comment, and many comments are tagging a friend (by writing @ and the account name) to ensure a friend sees the image. The lower engagement may be due to its smartphone-friendly interface. Users can access their accounts to view images on a computer, but posting photos is restricted to use of the Instagram app on one's smartphone. Additionally, Instagram does not convert hyperlinks, and normally, only a single link can be referenced in an account summary, making promotion of other websites using Instagram more cumbersome than Facebook.

Twitter is a medium that promotes short-form posts with a limit of 140 characters per post (or “tweet”). Shortened links count toward the character count, but Twitter changed its parameters in September 2016 to allow photo and video attachments outside the limit. While 24% of online Americans are estimated to have a Twitter account [2], few systematic studies of the scholarly use of social media, including Twitter, exist. A 2012 study of 8,826 scholars from 5 universities showed that 1 in 40 scholars (faculty, postdoctoral students, or graduate students) were active Twitter users [9]. A 2016 study of 587 academics recruited using Twitter showed that Twitter, Facebook, and LinkedIn predominate among academic scientists' use of social media [3] and that most scientist Twitter users consider fellow scientists to be their major audience [3].

Despite this, personal twitter accounts are used for a variety of non-exclusive purposes. Because both journalists and scientific journals promote science stories through their own accounts, Twitter can be a great listening device that facilitates quick news aggregation. Feeds can be organized by creating lists, which can filter feeds by topic if one is using Twitter to follow mainstream science news, science communication specialists, and tuberculosis researchers simultaneously. Additionally, users can subscribe

to others' lists and benefit from the curation of a well-informed group of subject experts.

Contributing newsworthy updates for common consumption is one way that Twitter users establish their expertise. This may be done by providing an aggregated literature search and regularly posting articles related to a specific subfield, such as the microbiome, which Elizabeth Bik both tweets and stores on her website [10]. Live-tweeting conferences to highlight major points made by different speakers also contribute science information for common consumption. These methods provide information that benefits the Twitter community and incentivizes those with similar interests to follow for future updates. These pieces of information also serve for community commentary via discussions of the statements.

Twitter hashtags are used to search by topic but are also useful within different twitter events, such as live tweeting during a seminar or scientific conference. During a conference, a hashtag established by conference organizers can help attendees (or those online) to follow the important points being made throughout the conference. Tweets can be collected based on their hashtags and saved using Storify, as was done for the 2017 ASM Biothreats meeting [11]. Conference hashtags can be especially useful for attendees who have conflicting conference sessions and cannot attend all the session they wish to. Additionally, viewing the tweets helps attendees find each other, which can happen through recognition of profile photos or through more formal "tweet-ups," where twitter community members meet at a given time and place, sometimes meeting for the first time in person after interacting for years online.

#Hashtags may also act as a quick cultural flash response. This was the case after Tim Hunt proclaimed that the trouble with women in the laboratory is the romantic relationships that inevitably follow; this popularized the hashtag #distractinglysexy as women responded by posting photos of themselves in laboratory gear. The #distractinglysexy hashtag seems to have been born from a single tweet calling for women to post photos of themselves at work [12]. More recently, in a move to allow members of the public who do not personally know anyone working in the sciences to visualize scientists, Auburn University ecologist David Steen called for scientists to introduce themselves and explain their science in a single tweet, with a response from Mary Roblyer to include the hash tag #actuallivingscientist [13]. The campaign was initiated to raise awareness of scientists and the contributions of their research.

Twitter also has several rotating accounts that maintain the same handle (the name after the @ symbol) but rotate hosts, and sometimes account names (the part prior to the @ symbol). The accounts exist to promote a specific niche: @realscientists is hosted by a scientist who discusses his or her science and science-related ideas in lay terms; @biotweeps similarly features different scientists with an emphasis on biologists; @iamscicomm is hosted by a user involved in science communication. The rotating hosts normally have an individual Twitter account but use the opportunity of an account with a broader reach to raise specific issues. The hosts initiate conversation among their followers through open-ended

questions and polls, in addition to anecdotes about the host's own experiences and opinions.

### **Applications of Social Media**

Social media interactions vary in their specific purposes. Common reasons scientists claim to use social media include increasing the size of one's network and communicating with both peers and the public [10]. Network building from curating within a subfield, discussing articles with the authors or other scientists, or soliciting advice on protocols or techniques may increase one's personal scientific endeavors, but there are additional applications of social media that aid science at the individual and the field levels.

#### **Branding**

Many users utilize social media to increase their personal brand. In the case of scientists, this may be to establish one's expertise in a particular subfield, for example, by curating and commenting on research in the subfield. Self-promotion of one's research or education protocols can also establish a niche within a field. This can occur through the use of personal accounts or by guiding community accounts on platforms like Twitter, where accounts like @realscientists, @iamscicomm, and @iamscicart have a new host each week. Hosting these accounts contributes to the greater scientific community and also to the established expertise of those invited to host one of the accounts.

Establishing one's expertise goes hand in hand with increasing one's network. This can occur through following colleagues or those with similar interests (e.g., science communications, genomics, etc.). Following colleagues after meeting them at a networking event, like a conference, can extend the relationship between two researchers; similarly, interacting with colleagues virtually can encourage interactions in real life.

#### **Education**

The educational aspect of social media is hard to deny. In addition to pointing colleagues toward interesting new research, opportunities abound to engage students and the lay public. Traditional university-associated, password-requiring online forums allow only course members to participate, but social media platforms allow outside students, professors, or experts to join the conversation. Shorter exercises, such as live tweeting a seminar speaker, provide the students an opportunity to summarize lecture points succinctly while maintaining accuracy.

Entire courses have been taught using social media: In 2016, 30 members of the Spanish Society for Microbiology described their experience using Twitter as a lesson delivery method [14]. Lectures were divided into tweet-size statements with associated links and images, and the course was aggregated with the hash tag #micro-MOOCSEM. Students were assessed in aggregate through quiz questions tweeted after each lesson. Overall, the authors concluded it was a successful effort, both as a means of active learning by the students and as a new method of teaching for the lecturers.

#### **Public outreach**

Social media makes expert advice and opinions more accessible to the public and its concerns. These concerns can be addressed

during Twitter chats, public conversations that are hosted by one account, such as the CDC (@CDCgov), and include several experts discussing a given topic in a short period. Hashtags funnel the tweets in chronological order for those participating or following along with the conversation. In addition to the question and answer format between the host and expert panel, individuals can join the conversation with their questions. This gives the general public a forum to ask questions about emerging infectious diseases, such as Zika, the importance of influenza vaccination, or antibiotic resistance.

Analysis of public chats, like that hosted by the CDC on Zika [15], can inform researchers and public health officials on the concerns of the public with emerging infectious disease, which may be different than the information provided to the public. In the case of the Zika chat, the CDC was emphasizing infection symptoms and prevention while the public was more engaged with the outcomes of infection for women and infants [16]. Addressing these popular public concerns may be a way to engage before providing important information on prevention and are also useful to prevent the spread of misinformation.

#### **Post-publication review**

In 2016, a paper published in the journal mSystems was the subject of social media discussion, generating controversy over a strong conclusion based on what some felt were tenuous results. The editor of the report, Jonathan Eisen, joined the conversation (collected in a Storify [17]) to discuss his rationale for deciding to publish the report as an “editor’s pick.” While critical, the discourse remained courteous, and Eisen responded with forthright explanations for his actions, as well as how the new conversation had changed his mind. This type of constructive post-publication review, previously concentrated in comments sections on websites like the NIH Pubmed Commons and bioRxiv (which also captures tweets for each article), facilitates transparency in publication decisions and interaction between editors, authors, and readers that promotes a culture of open science.

#### **Social media as a research tool**

Using social media as a listening tool allows researchers to learn behavioral patterns, given the right search terms. Researchers have used Twitter to track influenza in the United States [18], Zika in Latin America [19], and Middle East respiratory syndrome in the Middle East [20]. These studies show that social media tracking and Internet search history can complement traditional outbreak-tracking measures. Searches have even extended to the social restaurant review site yelp.com, which the New York City Department of Health and Mental Hygiene used to identify previously unknown foodborne illness outbreaks based on keyword searches [21].

Not all populations have equal access to social media or the Internet, and understanding the accuracy of social media broadcast cases is important to refine the identification of unreported subclinical infections. A University of Washington research group used geo-tagged dengue disease events on Twitter to study the relationship between reporting events on Twitter, socioeconomic status, and

confirmed dengue cases in an attempt to measure the accuracy of social media reporting. They found that populations most at risk for dengue-related morbidity and mortality were also less likely to tweet about dengue [22]. Their study highlights the important recognition that social media users are self-selected and do not necessarily represent the larger population.

The aggregation of individuals from around the world onto social media platforms has benefitted rare disease research. Scientists focusing on disease with low incidence can more easily find and interact with cohorts [23] and, conversely, parents of sick children can more easily interact with clinicians and form virtual support groups [24]. Most diseases for which these community structures have been utilized have been rare inherited genetic diseases, but infectious disease communities may use similar means to facilitate clinician-patient interactions and to build patient cohorts and communities given the success seen in other fields.

#### **Tips for New Social Media Users**

Regardless of what social media platform you want to start using, maintaining a constant stream of content is important. Try to post at least weekly, and read often. Just as reading is important to be a good writer, reading other social media accounts will help you know how to compose well-written posts. Write content that you personally find interesting; to quote Hope Jahren, author of Lab Girl, “Tweet like nobody is following.”

- Facebook fan page
- Notify others of your new account by inviting them to like the page.
- Monitor comments and conversations to ensure comments are cordial and on topic.
- Give proper attribution (with links) when necessary.
- Twitter
- Notify others of your new account by retweeting, liking, and replying to other posts.
- Include attribution and links when possible.
- Use hashtags (#) for key words.
- Use hashtags when live tweeting or joining Twitter chats.
- Tag accounts (@) to include others in a conversation.
- Attach videos or photos, and tag people in the photos when appropriate.
- Tools like HootSuite or Tweetdeck can help monitor key words and accounts.
- Instagram
- Notify others of your new account by following, liking, and commenting on other posts.
- Use hashtags related to the post for searchability.

#### **Conclusion**

Social media is the international water cooler for scientists of all types. You can stop to listen to emerging content, put up a flyer, or interact with others sharing their news. Microbiologists are

using social media to communicate with each other, with students, and with the general public. As increasing numbers of people use social media for communication and news sourcing, it is important that scientists adapt to new modes of communication. The most successful scientists, science communicators, and educators will continue to use social media as these platforms continue to evolve.

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