

When Scientists Tweet for Social Changes: Dialogic Communication and Collective Mobilization Strategies by Flint Water Study Scientists on Twitter

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Abstract

Guided by the literature in social media and science activism, this exploratory study examined how scientists from Virginia Tech, known as the Flint Water Study team, utilized Twitter to communicate and mobilize the public in response to the contamination of water with lead in Flint, Michigan. Results from the content analysis indicated that the scientists utilized Twitter mainly to provide scientific information to the public and that public education was their main advocacy tactic. This study offers insights into how this particular group of science activists utilized social media for collective actions and suggests future directions for science communication on social media.

Keywords

activism, politico-scientists, science activism, Flint Water Crisis

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In January 2016, Michigan Governor Rick Snyder declared a state of emergency in Flint, Michigan, where thousands of residents had been exposed to high levels of lead through their tap water. Approximately 10 days after Governor Snyder, U.S. President Barack Obama added his own declaration of emergency. The governor had been pretending for more than a year that there were no problems regarding the Flint water supply, and the federal government had taken no action until the emergency declaration.

The crisis began in April 2014 when the Flint city government changed its water source from the Lake Huron water to the Flint River. The Michigan Department of Environmental Quality (MDEQ) failed to uphold the federal Lead and Copper Rule requiring mandatory corrosion control treatment of the water from the Flint River, which resulted in lead leaching from old pipes and plumbing inside homes and buildings (Flint Water Study, 2016).

Dr. Marc Edwards from Virginia Polytechnic Institute and State University started the Flint Water Study—a research effort that helped Flint residents test the water quality and provided definitive evidence of widespread lead-in-water contamination.¹ The 38 participating scientists took on the role of science activists in raising awareness and communicating scientific information to the public and to the local and state government across various media, including Twitter. The current study examines the Twitter communication of Dr. Edwards's team from the first day they opened a Twitter account to 2 weeks after Flint water crisis was declared a national emergency. Building on previous studies in science activism, dialogic communication, and activists' social media mobilization, this case study presents a content analysis to examine the Flint Water Study scientists' social media tactics and strategies. Understanding how Flint Water Study scientists utilized Twitter to communicate with the public was the primary goal of this study.

Literature Review

Strategic Communication of Activists: Dialogic Communication and Social Media Mobilization

Activists are organized groups of people with a common social, political, or cultural goal for change (M. F. Smith & Ferguson, 2010). Activism is defined as a series of actions by which groups pressure organizations or institutions to change policies, practices, or conditions to which the activists object (M. F. Smith, 2005).

According to M. F. Smith and Ferguson (2010), activists communicate for two primary reasons: (1) to effect change and (2) to maintain an activist organization or the movement more broadly. To do so, activists utilize diverse

strategic communication tactics to increase awareness of the problem, position themselves as opinion leaders or experts on the issue, and argue for recommendations or resolutions to the public, target organizations, or the government (Crable & Vibbert, 1985; Hinsley & Lee, 2015).

Recently, social media has provided a channel that enables activists to engage with the public in a more interactive and direct manner than traditional news media (Bortree & Seltzer, 2009; Harlow & Guo, 2014; Taylor, Kent, & White, 2001). Digital activism through social media has become a way for individuals to participate in a cause or issue (Harlow & Guo, 2014). Social media can help activists diversify their tactics and engagement repertoires, extend their reach beyond time and space limits, and organize participation in protests and actions more effectively (Bennett, 2003; Theocharis, Lowe, van Deth, & García-Albacete, 2015; Valenzuela, Arriagada, & Scherman, 2012). Twitter has been identified as the main social media channel that activists use to manage the complexities of mass protest organization and coordination (Hinsley & Lee, 2015; Theocharis et al., 2015).

One of the theoretical approaches to examining activists' social media communication focuses on understanding activists' social media use as a form of dialogue with key publics (Bortree & Seltzer, 2009; Taylor, Kent, & White, 2001). Dialogue has been described as "any negotiated exchange of ideas and opinions" (Kent & Taylor, 1998, p. 325) and as "efforts by parties in a relationship to engage in an open, honest, and ethically based give and take" (Bortree & Seltzer, 2009, p. 317). Kent and Taylor (1998) emphasized that individuals engaging in dialogue do not necessarily have to agree but should share a willingness to reach mutually satisfactory positions and a goal of reaching intersubjectivity, not the objective truth or subjectivity.

Researchers have applied Kent and Taylor's (1998) concept of dialogic communication to see how activists utilize the Internet to engage and build a relationship with diverse publics. Examining activists' websites, Taylor et al. (2001) concluded that while the dialogic strategies in activists' websites are not employed to their full capacity, activists are successful in providing useful information and conserving visitors from their websites. Bortree and Seltzer (2009) found that environmental activists typically used features that were useful to visitors to their websites but that these features did not generate return visits, dialogic loop, or organization-public engagement on Facebook. Studies on nonprofit organizations found that they utilize social media to persuade people that their point of view is the ethical one (Auger, 2013), to provide information and call for actions to support (Guo & Saxton, 2010), and to build a community surrounding an issue of concern (Lovejoy, Waters, & Saxton, 2012).

While dialogic communication theory suggests social media offers the potential for dialogue with publics, studies find that scientists and advocates fail to utilize it for this purpose. For instance, research suggests that nonprofit advocacy groups have typically utilized Facebook or Twitter as one-way message channels (Bortree & Seltzer, 2009; Lovejoy et al., 2012; Seltzer & Mitrook, 2007). Similarly, Lee, VanDyke, and Cummins's (2017) examination of the National Oceanic and Atmospheric Association's use of social media reveals that it did not fully use the dialogic potential of social media. Lee et al. claimed such dialogic use of social media can increase public science literacy and trust in scientists as well as promoting public engagement in science.

On the other hand, some scholars approach activists' social media strategies from a traditional view of their mobilization efforts and collective actions (Jackson, 1982) to examine how social media changed activists' approach to mobilizing the public to act (Hinsley & Lee, 2015; Sommerfeldt, 2011). These studies suggest that regardless of the size or structure, activist groups utilize a variety of strategies to mobilize publics to participate in protests or take other actions (Jaques, 2006; Leitch & Neilson, 2001). Hinsley and Lee (2015) found that Jackson's (1982) five general categories of communication tactics were utilized by activists on Twitter: (1) informational activities, (2) symbolic activities, (3) organizing activities, (4) litigious activities, and (5) civil disobedience activities.

Studies utilizing Jackson's (1982) categorization of activist strategies have examined mobilization efforts on social media under the premise that the Internet has changed how political action takes place by not requiring activists to be physically present at a protest to pressure organizations and institutions (Hinsley & Lee, 2015; Theocharis et al., 2015). Specifically, Twitter has transformed the two major challenges to traditional protest mobilization: participation costs and the need for copresence (Theocharis et al., 2015). Hinsley and Lee (2015) found that while both journalists and activists utilized Twitter to supply information about the antiracism protests in Ferguson, Missouri, after the death of Michael Brown, activists were more likely to utilize symbolic activities, such as participation in protests. Examining Twitter use during heydays of mobilization in Spain, Greece, and the United States, Theocharis et al. (2015) found that Twitter was mainly used to facilitate discourse among activists, organizations, news media, and the public and to sustain the movement mobilizations that existed both online and off-line protests.

Two theoretical approaches emerge in studies of activists' use of social media. Studies applying the concept of dialogic communication to activists' digital media use imply that activists organized in groups intend to communicate to the general public to build dialogic relationships in order to promote their point of view (Bortree & Seltzer, 2009; Lovejoy et al., 2012; Seltzer &

Mitrook, 2007). On the other hand, studies examining activists' organizational efforts examine how social media can serve as a tool for collective action through communication, conversation, and information distribution during mobilizations (Earl, McKee-Hurwitz, Mesinas, Tolan, & Arlotti, 2013; Huang & Sun, 2014; Lotan et al., 2011). As Sommerfeldt (2011) argues, activists' mobilization strategies are indicative of their online relationship-building strategies.

Role of Science in Activism: Understanding Politico-Scientists

Social movement scholars have examined the ways scientists have collaborated with traditional activists to advance social change efforts in the public arena (Brown, 1992; Edge & Eyles, 2015; Frickel, 2004a; Lubitow, 2013) for a range of issues such as regulating bisphenol-A (Lubitow, 2013) and genetic toxicology (Frickel, 2004a) and preventing climate change (McCormick, 2009). These studies examined the mobilization of scientific experts and how scientists have been integrated into social activists' movements. Examining how scientists have collaborated with activists to mobilize publics and ultimately change policies in regard to bisphenol-A regulations, Lubitow (2013) found that scientists and activists crafted a set of frames focused on children's health, which not only were scientifically rigorous but also resonated with the general public. This led to a great deal of media attention and to successful mobilization efforts.

When scientists are engaged in political actions, they are interested in both educating the public about their scientific research and pressuring responsible target organizations or government agencies to increase regulatory measures to protect citizens from potential harm (McCormick, 2009). Labeled as "sympathetic scientists" or "politico-scientists" (McCormick, 2009, p. 36), such scientists are often the first to alert the public of harms revealed or predicted by their scientific research. Their goal is to make the scientific research accessible to laypeople so that the general public can prepare for any risks explained in the scientific results. Politico-scientists can serve as experts or agents of information when they utilize multiple forms of public outreach to increase public awareness of scientific knowledge and its relationship with social issues (Hess, 2005). Frickel (2004b) argued that scientist organizations can function as "collective-actors that have the potential to reshape broader political and cultural processes by identifying problems, constructing new identities associated with the problems, and legitimizing new expectations and boundaries" (p. 451).

While researchers have identified the collaborative efforts of activists and scientists, or individual efforts of scientists in bringing social change themselves,

little research has explored how science activists, or politico-scientists, use social media for both education and communication functions. The recent case of the politico-scientists of the Flint Water Study team and their use of social media can provide insights about how similar or different they are in utilizing social media for dialogic communication and mobilization.

Background: The 2014 Flint Water Crisis

In April 2014, Flint, Michigan, switched its water supply from Detroit Water Supply to the Flint River as a cost-cutting decision to save \$5 million over the next 2 years until a new supply line to Lake Huron was ready. In support of this switch, one official with the MDEQ verified that “the quality of water being put out meets all of our drinking water standards and Flint water is safe to drink” (Leber, 2016).

However, only a month after the change, Flint residents started to notice problems in their water. They reported developing rashes and eye irritations, but the city government advised them to boil their water, attributing such problems to the presence of *E. coli* bacteria in the supply (Eagan, 2016). In February 2015, the Environmental Protection Agency (EPA) water experts such as Miguel Del Toral and residents such as Lee Anne Walters started to report a high level of lead in the water supply. In March 2015, Veolia, a consultant group Flint hired, reported the city water met both the state and federal standards. They did not report on lead level directly or comment on citizens’ complaints or requests (Lin, Rutter, & Park, 2016).

Walters met with Dr. Marc Edwards, an expert on municipal water quality and professor at Virginia Tech. Soon after, Edwards launched an independent research team to investigate water quality in Flint, calling the project the Flint Water Study. Starting in August 2015, they analyzed 30 samples that Flint residents gathered according to their instructions. On September 2, 2015, Edwards’s team announced Flint’s water had elevated levels of lead, 13,000 parts per billion, far exceeding the EPA’s recommendation of 15 parts per billion (Flint Water Study, 2016). None of the samples the team analyzed was safe to drink.

The MDEQ disputed the conclusions on corrosion and lead leaching in Flint’s water supply (Flint Water Study, 2015). The Virginia Tech team nonetheless continued to advise residents of the troubling results and posted its documents and data online at flintwaterstudy.org. In late January 2016, acknowledging the elevated level of lead in Flint city water, Governor Rick Snyder appointed Dr. Edwards to a 17-member committee to deal with Flint’s lead crisis (Wisniewski, 2016). Dr. Edwards has testified in several congressional hearings, and he continues to be the trusted source among Flint residents in regards to improving the water quality (Hohn, 2016).

While investigations into those responsible for the switch are still underway, evidence suggests the switch to Flint River water contributed to the outbreak of Legionnaires' disease that killed the 10 people the state acknowledged in January 2016 and at least two additional people since (Hohn, 2016). It also likely increased spontaneous abortion rates; Grossman and Slusky (2017) reported increased rates of known fetal deaths as well as a 12% fall in birth rates after the switch compared to the average over the previous 8 years. The full impact of lead poisoning is yet to be discovered (*The Economist*, 2017), but according to Philippe Grandjean from the Harvard T.H. Chan School of Public Health, "When calculated from the loss of lifetime income, the societal costs from lead exposure reach billion dollar amounts" (Feldscher, 2016).

The Flint Water Study team played an essential role in validating residents' claims. The scientific research was used to pressure the local, state, and federal government to address the concerns Flint residents raised. During the process, public Michigan state officials criticized them and questioned about their scientific expertise, accusing them of falsifying results. As their website stated, members of the Flint Water Study identify as scientists first and advocates second (Flint Water Study, 2016), and Dr. Edward championed Flint activists' cause (Hohn, 2016). Karen Weaver, who was elected mayor of Flint, addressed the team directly in a public speech she made summarizing its role:

We had cried out for a year and a half, and it wasn't until you came that you gave our voice some validation. It wasn't until you came, and we got those Virginia Tech results, that we knew: People couldn't say we are crazy. They couldn't say we didn't know what we were talking about. They couldn't say it was our imagination. (Hohn, 2016)

A *New York Times* article summarized more succinctly, "Flint residents fought to be heard, and Dr. Edwards and the Flint Water Study team helped sound the alarm" (M. Smith, 2016).

The role Dr. Edward and his Flint Water Study team played in the Flint water crisis is a unique case of science activism that may suggest how scientists may advocate for the public good through research in the future. Flint Water Study scientists utilized Twitter and their original website primarily to communicate to the Flint residents. Thus, social media became a tool of their science activism. Thus, drawing from previous studies examining activists' social media tactics in engaging in dialogic communication and mobilizing publics, this study explores the social media strategies and tactics the scientists from the Flint Water Study utilized on Twitter with the following three research questions:

Research Question 1: How did Flint Water Study scientists use Twitter for dialogic communication with publics?

Research Question 2: What were the primary communicative functions of the Flint Water Study tweets?

Research Question 3: What types of advocacy tactics were used in the Flint Water Study tweets?

The final research question of this study addresses whether the Flint Water Study scientists tried to use the direct engagement and interactivity enabled by Twitter to position the issue in a broader political and social context. Studies examining scientific expert activism have suggested the active construction of frames by scientists in presenting the scientific results related to social issues (McCormick, 2009). When the expertise of scientists is combined with activists' claims, this can rapidly mobilize the general public (Frickel, 2004a, 2004b). Thus, the following research question will explore the broader political, social, and economic issues presented in social media communication from Flint Water Study scientists:

Research Question 4: What were the larger social issues Flint Water Study scientists connected to the Flint water crisis in their Twitter communication?

Method

To address the four research questions of this study, a content analysis of the tweets posted by the Flint Water Study was conducted. Original tweets posted by the Flint Water Study (@FlintWaterStudy) were collected via the advanced search function on Twitter from October 15, 2015 (the day Flint Water Study opened their Twitter account), through February 15, 2017, approximately a month after President Barack Obama declared the Flint water contamination to be an emergency. At this point, Flint Water Study scientists were no longer considered to be the single source of information raising the concerns related to the lead contaminations in Flint, as major news media outlets have started to report the water contamination of Flint as a national crisis. Thus, this study focuses on how Flint Water Study scientists utilized Twitter to communicate about the lead contamination independently and before the crisis received attention from national news media.

A total of 422 tweets were collected. As the focus of this exploratory research was to understand the social media communication of Flint Water Study scientists during the lead contamination crisis, a census of all the tweets posted in the Flint Water Study Twitter account was conducted. The

unit of analysis for this study was each tweet posted on the Flint Water Study Twitter profile during the study period.

Two coders participated in a 3-hour-long training session and then independently coded 50 tweets (approximately 17% of the total number of tweets) following recommendations from Neuendorf (2002). Intercooder reliability was calculated using the SPSS macro for Krippendorff's alpha (Hayes & Krippendorff, 2007). All variables established sufficient intercooder reliability coefficients, ranging from .92 to .96.

Operational Definitions

Operational definitions of main variables were adopted from previous studies examining activists' dialogic communication strategies (Bortree & Seltzer, 2009), communicative functions (Lovejoy & Saxton, 2012; Theocharis et al., 2015), and advocacy tactics (Guo & Saxton, 2014).

Dialogic communication: This study operationalized dialogic communication in three dimensions: dialogic loop, usefulness of information, and ease of interface. Initiation of dialogue was operationalized as whether each tweet was coded as replies to other Twitter users' tweets and retweeting of other users' original post. Replies on Twitter were considered a response to other users on Twitter, and retweets as giving acknowledgement to the original posts (Lovejoy et al., 2012). Usefulness of information was coded with the inclusion of links and the type of links included in the original tweet (Bortree & Seltzer, 2009). Finally, the ease of interface was operationally defined as the use of hashtags, as hashtags make searching for information easier (Lovejoy et al., 2012).

Communicative functions of tweets: Contents of each tweet was coded for the communicative functions, primarily based on the categorizations of Lovejoy and Saxton (2012) and incorporating mobilization strategies from Theocharis et al. (2015). Each tweet was categorized into three message-level schemes: information, community, and action (Lovejoy & Saxton, 2012). Tweets with the "information" function contain scientific findings or local and national news articles reporting on aid provided to Flint, government responses, information about Flint residents, information about events, and published opinions relating to the water crisis. "Community" tweets invited interaction and conversation within the community, which for this study included moral support to and from other activists related to Flint Water Crisis. The Action function was defined as the tweets encouraging followers to "do something" about Flint water contamination, which included political statements, live actions, and calls for action ($\alpha = .97$).

Advocacy tactics of tweets: Each tweet was coded for tactics used to influence local, state, and government decisions regarding the Flint Water Crisis, based on Guo and Saxton's (2010, 2014) operational definitions. This study modified Guo and Saxton's operational definitions to be better reflective of the Flint Water Crisis: science/research, media advocacy, direct lobbying, grassroots lobbying, public education, coalition building, Flint water expert testimony, electioneering, personal testimony, and other ($\alpha = .97$).

Social issues: Each tweet was coded for any mention of connection to social issues based on the operational definitions of McCormick (2009) and Theocharis et al. (2015). Thirteen social issues included race, poverty, economy of Flint, accountability of state governor Rick Snyder, Emergency Management, U.S. EPA, 2016 Presidential election, science, public health, environmental concerns, human rights, democracy, and bureaucracy ($\alpha = .95$).

Results

Research Question 1: Dialogic Communication Strategies

Research Question 1 asked about the types of dialogic communication strategies used in the Flint Water Study Twitter feed. The majority of the tweets were original posts ($n = 288$, 68.2%). Approximately 30% of the tweets ($n = 127$) were retweets of other posts. Only seven (1.6%) were replies to other users.

Examining the ease of interface, each tweet was coded for the use of hashtags. A total of 88 tweets (20.6%) had hashtags. Hashtags that appeared more than once were #FlintWater ($n = 24$, 8.5%), #CitizenScientists ($n = 4$, 1.4%), and #FlintWaterCrisis ($n = 2$, 0.7%).

Last, the usefulness of information was examined with whether the tweet included links to other sources. The majority of the tweets from the Flint Water study contained links ($n = 363$, 86%); only 34 tweets included no hyperlink of any kind (12.1%). The most frequently tweeted external links were online news articles Flint Water Study members had written ($n = 170$, 40.3%). The second most frequent were links to the Flint Water Study website ($n = 95$, 22.5%). Photos were a distant third ($n = 43$, 10.2%). Other types included links to blogs ($n = 11$, 2.6%) and petition sites ($n = 10$, 2.4%; see Table 1).

Research Questions 2 and 3: Communicative Functions and Advocacy Tactics of Flint Water Study Tweets

Research Question 2 examined the types of communicative functions used in Flint Water Study tweets. The majority of the tweets communicated

Table 1. Types of Hyperlinks in Flint Water Study Tweets.

Types of hyperlinks	Frequency	%
News article	195	46.2
Flint Water Study website	95	22.5
Photos	43	10.2
No link	33	7.8
Blogs	11	2.6
Other	11	2.6
Petition	10	2.4
Videos on YouTube/Vimeo	6	1.4
Photo/videos on social media accounts	5	1.2
Other scientists	5	1.2
Movement websites	4	0.9
Opinion	4	0.9
Total	422	100.0

information (58.5%), with the largest number of tweets focused on reporting news about Flint in general ($n = 88$, 20.9%) followed by reporting science/research related to the water ($n = 37$, 8.8%). Flint Water Study tweets also described actions ($n = 140$, 33.2 %) with the majority of the action tweets focusing on making political statements to local, state, and federal government. Tweets also called on social media users to take action ($n = 54$, 12.8%), sometimes specific actions for Flint ($n = 13$, 3.1%). Community function was found through moral support from other activists and citizens concerned with Flint ($n = 19$, 4.5%; see Table 2).

Research Question 3 was about the advocacy tactics used in the Flint Water Study Twitter communication. Among advocacy tactics, public education ($n = 147$, 34.8%) and expert testimony ($n = 91$, 21.6%) were the most frequently used. The science/research tactic was observed 55 times (13%), followed by grassroots lobbying ($n = 27$, 6.4%). The least utilized advocacy tactic was direct lobbying ($n = 3$, 0.7%; see Table 3).

While not stated in the research questions, the use of different advocacy tactics for each communicative function was explored. Among tweets focusing on action, such as political statements, the public education ($n = 35$, 47.9%) and expert testimony ($n = 18$, 24.7%) were the most frequently used tactics. Among tweets focused on providing information about water conditions in Flint, the same tactics were most frequently utilized ($\chi^2 = 498.12$, $p < .001$), in slightly different numbers (public education tactic: $n = 36$, 40.9%; expert testimony: $n = 25$, 28.4%).²

Table 2. Types of Communicative Functions Used in Flint Water Study Tweets.

Communicative functions	Type	Frequency	%
Information	Reporting news about Flint	88	20.9
	Science/research	37	8.8
	Information, fact, or opinion with no news	34	8.1
	Reporting news about science	24	5.7
	Reporting news about government responses	22	5.5
	Providing information of upcoming event	15	3.6
	Reporting news about aid provided to Flint	13	3.1
	Reporting news about citizens in Flint	12	2.8
	Total	245	58.5
Community action	Moral support	19	4.5
	Political statement	73	17.3
	Live action	54	12.8
	Call for action	13	3.1
	Total	140	33.2

Table 3. Types of Advocacy Tactics Used in Flint Water Study Tweets.

Tactics	Frequency	%
Public education	147	34.8
Expert testimony	91	21.6
Science	55	13.0
Other	30	7.1
Grassroots lobbying	27	6.4
Personal testimony	21	5.0
Coalition building	16	3.8
None	13	3.1
Media advocacy	12	2.8
Electioneering	7	1.7
Direct lobbying	3	0.7
Total	422	100.0

Research Question 4 assessed the types of social issues Flint Water Study scientists tried to associate with the lead contamination in Flint. The majority of the tweets did not associate any other social issues with the Flint water crisis ($n = 140$, 33.2%), but among those that did, public

Table 4. Social Issues Mentioned in Flint Water Study Tweets.

Social issues	Frequency	%
None	155	36.8
Public health	62	14.7
Accountability of Governor Rich Snyder	52	12.3
Accountability of U.S. Environmental Protection Agency	50	11.8
Other	45	10.7
Accountability of emergency managers/state emergency operation in Michigan	25	5.9
Democratic legitimacy of government's actions	13	3.1
Bureaucracy	7	1.7
Economy of Flint	5	1.2
Human rights	3	0.7
Racial issues in the United States	2	0.5
Environmental concerns	2	0.5
Poverty in Flint	1	0.2
Total	422	100.0

health was the issue most often mentioned ($n = 62$, 14.7%), followed by the accountability of Governor Rick Snyder ($n = 52$, 12.3%) and the EPA ($n = 50$, 11.8%; see Table 4).

As an additional analysis, the types of advocacy tactics used for each social issue was examined. Tweets that utilized science as the main advocacy tactic generally did not mention any social issues at all ($n = 34$, 61.8%), though 11 tweets referenced public health (20%). A similar pattern was found for tweets utilizing the public education tactic, most of which did not invoke any social issues ($n = 39$, 26.5%). Exceptions generally mentioned public health ($n = 25$, 17%), the accountability of Governor Rick Snyder ($n = 25$, 17%), or the accountability of the EPA ($n = 10$, 6.8%; $\chi^2 = 226.076$, $p < .001$).³

Discussion

This exploratory case study focused on examining how Flint Water Study scientists utilized Twitter as a communication and mobilization channel to raise awareness about the lead contamination of Flint water before the national news media reported on the issue as a national-level crisis. Previous studies on activism and politico-scientists have suggested the unique role scientists played in presenting social issues with research and facts in a manner that is approachable and understandable to laypersons (Frickel, 2004a; Lubitow, 2013; McCormick, 2009). Findings from a content analysis indicate

Twitter was primarily used to educate the public about the scientific facts and research related to lead contamination in Flint water. It was also used as a tool to pressure local, state, and federal government officials and mobilize both Flint citizens and the general public with science/research as the primary advocacy tactic used in its communication.

In the case of the Flint Water Study Twitter communication, the use of dialogic communication strategies, such as replies to other users, was relatively lower than the use of original tweets, similar to previous studies (Lee et al., 2017). Thus, the lack of dialogic communication strategies in the Flint Water Study Twitter communication is similar to other scientists' use of social media in communicating scientific results to the general public. As residents of Flint had already built trusting relationships with the scientists via face-to-face communication (Hohn, 2016), dialogue on Twitter between Flint Water Study scientists and Flint residents may not have been entirely necessary. Findings indicate that the Flint Water Study mainly used Twitter to communicate the relevant facts in a one-way direction, especially in terms of science and research, not necessarily in creating dialogue with the public. However, we found other dimensions of dialogic communication in the Flint Water Study Twitter communication. There was a prominent use of retweets and hyperlinks that provided acknowledgement to other users' posts and also ensured the usefulness of information. Retweets may have served as an indirect dialogic loop between the Flint Water Study and other Twitter users, while the use of diverse hyperlinks ensured the information provided was useful and generated return visits.

The lack of replies and hashtags on Twitter between users and the Flint Water Study Twitter feed needs further interpretation in terms of public outreach and engagement from scientists. For example, Nisbet and Scheufele (2009) emphasized the role of scientists' public engagement to meaningfully involve the public on societal issues connected to science and emerging technology. Although the main goal for Flint Water Study scientists on Twitter might not have been primarily about engaging with the general public outside of the Flint area, initiation of dialogue, such as replies to other users or use of hashtags, had the potential to make the issue more viral in social media even before the lead contamination received national attention via news media. For example, Freelon, McIlwain, and Clark (2016) identified the use of hashtags in social media posts by activists as essential in initially spreading the story of Michael Brown's death in Ferguson, Missouri, at a national level. As interest in science communication is growing, activists who are concerned with changing the status quo for scientific issues, such as environmental issues, will also need to understand how to communicate scientific facts for better engagement, dialogue, and mobilization.

A majority of the tweets posted by Flint Water Study scientists included links to online news articles about the lead contamination in the city. In keeping with the idea that one of the key roles of news media during crisis is to fill the information void and reduce uncertainty (Lachlan, Westerman, & Spencer, 2009), the Flint Water Study Twitter communication focused on “pushing” the news content to their followers on Twitter about lead contamination and the current status of Flint water. This communication pattern resembles findings from previous studies about how scientists communicate when presenting scientific facts to the general public. For example, Irwin and Wynne (1996) argued that scientists tend to focus on transmission of knowledge. Although understanding the scientists’ in sharing news content via Twitter is not within the realm of the current study, the traditional “push” communication of scientific facts on Twitter is limited in engaging audiences (Nisbet & Scheufele, 2009). Given the main strength of social media for activists’ cause is not only to mobilize but also to engage in interactive dialogues (Kent, Taylor, & White, 2003; Taylor & Das, 2010), the lack of dialogic communication suggests the limitation of impacts the Flint Water Study may have had on the issue prior to the national news coverage.

As with any exploratory study, the current study is limited from specifically focusing on Flint Water Study scientists as a case to explore science activism and its use of social media interactivity. This prevents us from making any generalizable claim about how science activists utilize social media. Thus, future studies examining broader groups of science activists are needed to further understand their social media use. For example, in-depth interviews with politico-scientists to understand the motivations and intended influence of using social media as a main channel to communicate science can be useful to gain deeper insights in understanding the self-positioning of scientists as politico-scientists/activists. Understanding dialogic communication through content analysis does not explain scientist’s intentions for dialogue or whether they are more interested in persuading others of a certain position, and future studies examining the intentions and motivations of scientists utilizing social media are essential for science activism. Similarly, whether reading the tweets influences public trust toward science activists can be tested with an experiment, which can help scientists understand the impact of their social media use on public understanding of scientific evidence behind any activists’ social causes.

The current study also did not explore the dialogic communication strategies and tactics on the Flint Water Study website. The Flint Water Study scientists may have utilized Twitter primarily as a conduit to direct users to their website, which provided more detailed information than 140 characters allow. Follow-up studies examining both the website dialogic communication and

utilizing qualitative methods, such as discourse analysis, of the tweets can provide deeper understanding of how Flint Water Study scientists communicated during this crisis.

Although this study is limited to one case of science activists, findings from this case study add to the understanding of social media use by science activists utilizing their scientific research for the public good. This study can serve as a basis to examine social media communication of science activists and suggest tactics for science activists and science communicators to utilize for effectively engaging and educating the public on diverse social issues.

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Notes

1. Thirty-eight civil engineering scientists from Virginia Tech including 11 undergraduate students, 16 graduate students, 7 postdoctoral and research scientists, 1 staff, and 3 principal investigators including Dr. Marc Edwards, Dr. Amy Pruden, and Dr. Joseph Falkinham III participate in the Flint Water Study. One of the graduate students, Siddhartha Roy, started the Twitter account and has been in charge of managing the Twitter feed as a communication director. Other team members have access to the Twitter account, but Mr. Roy manages the content. More information can be found from their website: www.flintwaterstudy.org.
2. Cross-tabulation table for advocacy tactics and communicative functions is available from the authors.
3. Cross-tabulation table for social issues and advocacy tactics is available from the authors.

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