

Science bloggers' self-perceived communication roles

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Abstract

This study addresses an open question about science bloggers' self-perceived roles as science communicators. Previous research has investigated the roles science journalists see themselves engaging in, but such research has failed to capture the experiences of science bloggers as a broad and diverse group that is yet often very different in their practices from professional journalists. In this study, a survey of over 600 science bloggers reveals that on the broadest level, science bloggers see themselves engaging most often as explainers of science and public intellectuals. Perceived communication role depends predominantly on occupation, science communication training, blog affiliation and gender.

Keywords

Science and media, Scholarly communication, Science and technology, art and literature

Context

Blogs are flourishing as a medium of science communication. In the context of this study, a science blog is a "macroblog", conceptually different than a "microblog" such as an author's Twitter timeline [Zivkovic, 2012], featuring content that disseminates, explains, comments upon, investigates, aggregates or otherwise deals with science, scientific research, science communication, science policy, science in society and/or other science-related concepts or events [Wilkins, 2008]. Gauging by science blog content, science bloggers see themselves engaging in a variety of roles from science explainers to agenda setters to science journalists. However, few studies have attempted to broadly investigate the diverse roles of science bloggers from their perspective. In 2009, Mitchelstein and Boczkowski made a call for missing studies "of the practices, interpretations, and experience of bloggers" [2009, p. 577]. While some science bloggers have themselves conducted informal investigations into the roles their community engages in (e.g. journalism, media analysis, science education, re-contextualization of science into popular culture) [Zivkovic, 2009], little peer-reviewed research has done the same. The motivation to investigate how science bloggers perceive their roles is to understand what blogs offer in an expanding but fragmented online science media environment. Do science bloggers overlap in their perceived roles with trained science journalists, or do they see themselves engaging in roles traditionally less common among journalists, e.g. public intellectuals or advocates? What implications do their perceived roles have for readers, or for a science media environment that has anecdotally come to rely on blogs to provide context missing from traditional media [Bonetta, 2007; Zivkovic, 2009]?

Blogs today are an important component of an expanding science media ecosystem [Masters, 2013; Fahy and Nisbet, 2011; Brumfiel, 2009], even if they serve to primarily compliment as opposed to replace traditional media sources [Anderson, 2013]. This ecosystem includes legacy news media science sections, magazines, aggregation sites and social media sites. Previous observations about science bloggers' practices include that they often add context missing from science news coverage [Masters, 2013; Wilkins, 2008; Zivkovic, 2009] and contribute a more personal account of science: "The best science bloggers allow judicious amounts of eccentricity and personal style — attitude — to seep into their posts" [Costello, 2012]. As an increasing number of scientists take up blogging, blogs also promote interaction between scientists and the general public [Elliott, 2006; Shanahan, 2011] and reveal science-in-the-making [Wilkins, 2008]. Some bloggers tell other scientists' personal stories, thus acting as "conveners" bridging communication gaps between scientists and non-scientists. Some bloggers hold researchers accountable for ethical conduct (Retraction Watch and KSJ¹) and for transparency in scientific publishing and peer-review (#OAontheway, nature.com²) in ways that many traditional journalists can't or don't. It would be interesting to know which factors might help determine whether and how science bloggers engage in these various roles and functions.

Science blog content can start conversations about important issues in science and academia (an agenda-setting role) and serve as fodder for science journalists. Blogs have been found to influence the op-ed pages of mainstream newspapers [Schiffer, 2006] and to be sources of information and story ideas for science journalists [Brumfiel, 2009]. However, several scholars suggest that science blogs have largely not replaced journalism [Brown, 2014; Brumfiel, 2009; Domingo and Heinonen, 2008]. There is now dated evidence that bloggers mostly have no intention of becoming journalists [Lenhart and Fox, 2006]. By investigating modern science bloggers' perceived communication roles, I hope to provide a better understanding of why people use these blogs and what science communicators and scholars can expect of them, e.g. should we or shouldn't we be counting on bloggers to watchdog the scientific research process or critique science reporting?

I am not aware of any published research broadly investigating science bloggers' self-perceived roles with regards to setting the agenda on scientific issues in the media, watchdogging, popularizing science, or performing other science communication roles described by Fahy and Nisbet [2011]. Understanding science bloggers' relative engagement in these roles could help us more rigorously understand how blogs fit in to the larger science media ecosystem, beyond anecdotal evidence, and assess or suggest improvements for blogs based on what readers need or what is missing from traditional science media sources.

Science communication roles

In 2011, Fahy and Nisbet mapped out the new science media environment by interviewing journalists and writers from U.S. and U.K. media organizations and describing how the roles of science journalists have shifted under new media

¹<https://ksj.mit.edu/tracker/2014/06/facebook-tried-to-manipulate-user-emotions-for-study-journalists-cite-improper-informed-consent/>.

²<http://www.nature.com/spoton/tag/oaontheway/>.

pressures. They created a typology of roles based on background research and their findings. These roles include that of *conduit or explainer* “explaining science understandably to non-specialists,” [Fahy and Nisbet, 2011, p. 787]; that of *curator of information* “sifting through and evaluating the vast amount of science-related content,” [p. 787]; that of a *civic educator* or creator of contextualized science reporting with a bent toward education; that of a *public intellectual* presenting on specialized topics from a distinctive worldview; that of an *agenda-setter* “making a story acquire legs and really start moving and change what governments think,” [p. 789]; that of a *watchdog*; and that of a *convener* connecting scientists with non-scientists. They asked 11 interviewees engaged in science journalism in various forms if they regarded their work as fitting into each of the above role categories, and if so, how. They found that science journalists’ roles heavily revolve around explainer journalism and curation of science media content, but that science reporters also often see themselves being watchdogs and conveners, and occasionally although increasingly civic educators and public intellectuals.

But Fahy and Nisbet [2011] focused their study of roles on a small group of elite media and professional science journalists and/or writers. Their study, along with many others on the practices of science bloggers [Ranger and Bultitude, 2014], was limited by a relatively non-diverse (and predominantly male) sample. Little research has focused on the self-perceived roles of science bloggers as a broad and diverse group, including amateur writers and scientists-in-training who blog. Previous studies on the roles and content approaches of science bloggers have largely focused on either scientists blogging in a more scholarly context [Bonetta, 2007; Colson, 2011; Jarreau, 2014b; Mahrt and Puschmann, 2014a; Puschmann and Mahrt, 2012; Trench, 2012], on “A-list” popular science bloggers [Ranger and Bultitude, 2014], or traditional journalists who’ve taken up blogging [Hermida, 2010]. While these different groups of science bloggers may well have fundamentally different goals and self-perceived roles that justify studying them separately, scholarly research has yet to investigate or confirm this.

The roles science bloggers see themselves engaging in likely depend on a variety of factors including occupational area (e.g. professional writing vs. academic research), blog affiliation (e.g. blogging on an independent Wordpress blog or for a prominent blog network) and other individual factors such as gender [Meraz, 2008], age and education. Various individual factors might influence bloggers’ tendency to engage as media critics or watchdogs. In previous studies, female journalists³ have been found to see themselves less in a watchdog role than male journalists [Hanitzsch and Hanusch, 2012], and to focus more on positive aspects of stories [Craft and Wanta, 2004; Rodgers and Thorson, 2003]. Other factors that likely affect science bloggers’ self-perceived communication roles include editorial oversight and pay. These factors may lead science bloggers to align their goals and their approaches to content creation with those of other professional online science writers.

Who are science bloggers?

There are many different groups of individuals who engage in science blogging, including scientists, students or scientists-in-training, educators, science journalists,

³Not specific to science journalism.

freelance and amateur science writers, and public information officers for scientific organizations. Below I discuss some blogging characteristics, established in previous research, of two broad groups of science bloggers: scientists and science journalists. While grouping science bloggers this way vastly over-simplifies the diversity of the science blogosphere, previous research has predominantly focused on the goals and blogging practices of these groups separately. This study will investigate the perceived communication roles of these two groups, as well as other types of science bloggers, as a larger and broader group.

Scientists in the Blogosphere. In a recent Pew report of 3,748 U.S.-based members of the American Association for the Advancement of Science (AAAS), 24% of these scientists reported having blogged about science and/or their research in the past [Rainie, Funk and Anderson, 2015]. While Twitter has become a prominent social media venue for scientists to communicate their work to a broader audience [Puschmann, 2014], blogs remain popular platforms for outreach, research communication and scholarly discussion at length [Bik and Goldstein, 2013], especially among younger scientists [Rainie, Funk and Anderson, 2015]. In some ways, scientists' blogs have become an intermediary between academic publishing and news writing, with an intermingling of editorial-type writing and scholarly commentary. Blogs written by scientists have been argued to "provide an authoritative opinion on a topic, often within a richer context than, for example, a news article" [Bonetta, 2007, p. 445].

While researchers can and do use blogs to communicate their own research to both peers and a broader audience, this may not be the most common use case for blogs by academics and researchers [Mahrt and Puschmann, 2014a; Mahrt and Puschmann, 2014b].

Researchers and popular science writers alike are using blogs to blend their own specialized knowledge with science published by others, with popular media and with user-generated content in a way that recontextualizes science for the public sphere [Luzón, 2013]. Much of this type of blogging can be likened to explanatory science journalism. In a 2014 study of 44 SciLogs.de network science bloggers, only 11% of the bloggers — many of whom are active scientists — indicated that they blog mostly about their own research [Mahrt and Puschmann, 2014a; Mahrt and Puschmann, 2014b]. Instead, science blogs are often an outlet for scientists to participate in broader scholarly conversations and to explore/explain science outside of their own research area(s).

Academics often start their blogs as teaching tools and expand their blogging role(s) from there.⁴ Many bloggers may see themselves as public educators or even advocates, "trying to raise the level of discussions e.g. on climate change or evolution" [Blanchard, 2011, p. 221; Goldstein, 2009]. Blogging in this genre can look a lot like popular science journalism, either in communicating science in fun and interesting ways for a wide audience or in revealing the science behind events and issues such as chemical spills⁵ or irreproducibility⁶ in science. The latter may

⁴Observation from previous but unpublished research by the author, examples including Rhett Allain's "Dot Physics" blog at Wired and Joseph Meany's "Crimson Alchemist" blog.

⁵<http://www.wired.com/2014/01/chemical-guesswork-in-west-virginia/>.

⁶<http://rrresearch.fieldofscience.com/search/label/%23arseniclife>.

also overlap with blogging to “watchdog” science for the benefit of both the research community and citizens at large.

Science Journalists in the Blogosphere. Many science media producers today employed by traditional media organizations such as *National Geographic*, *Discover*, *Popular Science* and *Scientific American* first developed their writing chops in the blogosphere. Economic pressures and technological changes, including the rise of blogs and microblog social media tools, have driven a multiplication and diversification of the roles played by science news media producers [Fahy and Nisbet, 2011]. Several of these newer roles, including public intellectual and civic educator, may be driven in part by the fact that rising ranks of science bloggers are not only skilled in producing journalistic products, but are often equipped with high-level scientific expertise as current or former scientists and graduate students. However, to my knowledge no research has investigated whether education or experience in scientific research are factors that help determine science bloggers’ self-perceived communication roles. As Anthony Dudo recently pointed out, “[b]asic research is still needed to provide a better descriptive sense of scientists and their use of social media” including blogs [2015, p. 768].

Many science bloggers, again perhaps depending on education and occupation in or outside of scientific research, might perceive themselves as providing needed context to news reports of science: “many science bloggers consider themselves as qualified (or even more) as science journalists” [Colson, 2011, p. 898]. As a *Nature* editor put it in 2010, “[m]any researchers’ blogs [...] contain better analyses of the true significance of a scientific finding or debate than is seen in much of the mainstream media” [Response required, 2010]. As researchers and journalists occupy some of the same media spaces, including science blog networks (sites/platforms that combine multiple individual blogs) and news sites such as *The Conversation*,⁷ the roles played by each begin to blur. Social media environments have created an “overlapping information and communication space” [Trench, 2009, p. 167] “in which scientists, journalists, advocates, and the people formerly known as audiences are all content contributors” [Fahy and Nisbet, 2011, p. 782].

Objective

The objective of this study is to investigate the self-perceived roles of a diverse sample of bloggers who write predominately about science, broadly speaking, and how these roles relate to characteristics including but not limited to gender, occupation, blog affiliation and training in science communication. The following three research questions are addressed within the context of this study. The purpose of addressing these research questions is to construct a more detailed picture of the self-perceived roles of science bloggers. By doing so, I hope to establish a framework for others to study the potential and actual impact of science blog content on readers as well as on the larger science media ecosystem. This study helps other scholars and practitioners put blogs into context as far as what they offer relative to other science media outlets.

⁷First in the U.K. (<https://theconversation.com/uk>) and now also in the U.S. (<https://theconversation.com/us>).

RQ1. What science communication roles do science bloggers see themselves engaging in?

This study investigates how often different groups of science bloggers see themselves engaging in the science communication roles describes in Fahy and Nisbet's 2011 typology.

RQ2. Are these self-perceived roles different for different bloggers based on individual factors such as gender, experience, training in science communication, etc.?

RQ3. Are these self-perceived roles different for different bloggers based on occupation within the field of journalism vs. occupation within the field of scientific research?

Science bloggers' perceived communication roles likely depend on a variety of individual and structural (related to structural elements of the blog such as affiliation with a blogging network) factors. These individual factors include a blogger's primary area of occupation, education, blogging experience, age and gender [Meraz, 2008]. Age and years of blogging experience may influence self-perceived communication roles as more experienced bloggers have passed through different phases of their blogging [Crew, 2012] and may have gained the popularity [Ranger and Bultitude, 2014], authority or influence to justify engaging more in particular communication roles (such as public intellectual, agenda-setter, media critic or watchdog). Alternatively, popularity or prominence conferred by having a blog hosted on a mainstream media network might lead bloggers to engage less in the role of media critic and more in the roles of explainer or investigative reporter. This shift could follow having to abide by the standards of the media organization hosting one's blog [Jarreau, 2014a], getting paid to blog or having to answer to a blog editor. The later are more structural factors. Other factors that might impact science bloggers' self-perceived communication roles include training in science communication (via workshops, etc.). In receiving training in two-way vs. one-way models of science communication [Trench, 2008], some bloggers may come to see themselves needing to engage less as educators and "correctors" of bad science reporting, and more as explainers and conveners bringing scientists and the public together for meaningful discussion, for example [Dudo, 2015].

This study investigates science bloggers' perceived communication roles across a range of individual and structural factors.

Methods

I conducted an online survey (titled "#MySciBlog survey") among a large sample of active science bloggers in order to investigate their self-perceived roles and related content approaches. Survey questions were both broadly and specifically informed by a preliminary investigation of blogging practices via in-depth interviews with over 50 active science bloggers [Jarreau, 2015]. This preliminary study of blogging practices informed the online questionnaire for this study, for example in asking about editorial control and specific blogging approaches and styles. Survey questions were pilot tested among a population of 20–30 SciLogs.de science bloggers (during a conference in Deidesheim, Germany), and modified for clarity

based on initial feedback. The survey was administered via Qualtrics in a mobile-friendly format and distributed via web-based channels targeting active science bloggers. The data collection and analysis protocol was reviewed and approved by the Institutional Review Board at Louisiana State University, Protocol #E9033.

Sample and data collection

The online survey was distributed via a Bit.ly shortlink to a variety of social media channels, listservs and personal contacts, with the aim of reaching active science bloggers broadly defined. Potential participants were greeted with an introductory message and an inclusive description of what counted as a science blog, in line with this study's objective of examining the perceived roles of a diverse sample of bloggers who write predominately about science. Amazon.com e-card survey rewards (\$7.00 each) were distributed manually to a subset of the first 200 vetted science bloggers who fully completed the online survey.⁸

The survey launched on November 28, 2014 and closed on December 19, 2014. Social media channels used to distribute the survey included Twitter,⁹ LinkedIn, Google+, Reddit, Facebook, and a number of high profile blogging sites. The online survey was also distributed to several popular science writing and science communication listservs.¹⁰ A call for survey participation was distributed by request to the blogger back-forum at *Scientific American's* blogging network, and was sent to digital/blog editors (via e-mail and directed tweets) at *Popular Science* magazine, *Discover* magazine, *National Geographic* magazine and several other popular blog networks. Finally, to ensure survey distribution beyond the researcher's own social network ties, a direct request for survey participation was tweeted at or emailed to¹¹ a systematic random sample of the 2,122 blogs indexed at ScienceSeeker.org (every 10th blog, based on a random start, selected from an alphabetical list of all indexed 2,122 blogs). Direct contact via these modes of communication was possible for the vast majority of blogs sampled from the ScienceSeeker index. This strategy provided a robust sample of the English-speaking science blogger population, with final data analysis based on 610¹² valid and complete survey responses.

⁸Funding obtained via an Experiment.com crowd-funding campaign. Each of the first 200 qualifying participants were prompted to indicate whether they would like to a) receive their \$7.00 reward via a designated e-mail address, or b) donate their reward back to the researcher to fund subsequent research on this topic or pay for open access publishing fees, etc.

⁹Several prominent accounts tweeted or retweeted the survey on Twitter, including ScienceSeeker (@SciSeeker), *Scientific American* magazine (@SciAm, @SciAmBlogs), Science Borealis (@ScienceBorealis), Research Whisperer, SciencePress (@SciencePresse), RealScientists.org (@RealScientists), National Association of Science Writers (@ScienceWriters), and a large number of popular science bloggers' personal Twitter accounts.

¹⁰NASW-talk, Psci-com listserv, International Network on Public Communication of Science and Technology listserv, ASC-list Digest listserv.

¹¹If the listed blog had a single author, the Twitter handle (primary mode of contact) or e-mail address (secondary mode of contact) of the author was located via the blog homepage or a Google search, and a direct request for survey participation was sent to the author directly from the researcher's Twitter handle or work e-mail address. If the listed blog had multiple authors, the request for survey participation was directed at each author individually, or at a group blog Twitter handle or email address or contact form if available.

¹²From over 800 survey responses, some of which were incomplete and/or spam responses.

Measures

Perceived Role. Survey respondents were asked how often they engage in each of the new media communication roles explicated by Fahy and Nisbet [2011]. Extent of engagement was measured for each of these roles on a Likert-type Scale ranging from 1 (Never) to 5 (Always).

Blogging Approach. In a matrix survey item I asked respondents how often they use the following approaches in their blogging: journalistic (reporting on science in a more traditional fashion, often interviewing researchers and getting outside comment), editorial (presenting your opinion on an issue/event, as well as factual information), translational/explainer (translating or explaining science based on your own knowledge, often in the absence of traditional journalistic reporting / interviewing), curation (curating information, often linking to diverse sources, with or without adding commentary yourself), and analysis (collecting, creating and/or analyzing data). Use of each of these common blogging approaches was measured on a Likert-type Scale ranging from 1 (Never) to 5 (Always).

Blog Affiliation. For data analysis, blog affiliation was collapsed into a single variable for network blogs (1) vs. other blogs (0). Survey respondents indicated the affiliation or online location of their primary science blog by selecting all that applied among the categories listed below.

Affiliations classified as network blogs included: a government website (5), *Discover* (5), *Popular Science* (6), *The Guardian* (10), *National Geographic* (1), *Nature* (editorial) (4), *Science 2.0* (1), *Scientific American* (13), *ScienceNews* (1), *Scientopia* (2), *SciLogs* (15), *ScienceBlogs* (9), *PLOS* (5), *Wired* (4), other non-profit organization website (e.g. Planetary Society blogs, AGU blogs) (30), other traditional media organization staff blog (11), other alternative media platform (e.g. Medium.com) (9), other network blog site (44). Affiliations classified as “other” or non-network blogs included: an independent blog site (n = 400), *Science Borealis*¹³ (12), a social network such as Tumblr (n = 39), other non-network site (12).

Blogging Experience, Posting Frequency and Pay. Blogging experience was measured in terms of number of years since the respondent first started blogging, ranging from 0 to over 10. Posting frequency, a control variable here, was measured on a 7-point scale from multiple times a day to less than once a month. Bloggers were also asked whether or not they earn money or are paid for their main science blog.

Editorial Oversight. Editorial oversight was measured by asking survey respondents whether they had a blog editor or someone in a similar role.

Demographic and Other Variables. Measured demographic variables included gender, age, education and occupation. Measured levels of education ranged from

¹³Blogs listed as independent and belonging to *Science Borealis*, or only as belonging to *Science Borealis*, were coded as non-network blogs. *Science Borealis* is an index of Canadian science blogs that brings independent science bloggers' sites under a single online database of posts.

high school diploma to Doctorate and professional degrees. Respondents indicated via multiple choice their primary area of occupation, including academic research, non-academic research, education, medicine/public health, engineering, media/public relations, journalism, science writing, science publishing, science outreach, other professional communication or other. For the purpose of data analysis, this multiple choice occupational area variable was recoded into dichotomous variables for occupation in research (academic and non-academic research collapsed and recoded as '1' and all other occupational areas recoded as '0') and occupation in science writing (science writing and journalism collapsed and recoded as '1' and all other occupational areas recoded as '0'). Respondents were also asked whether or not they had any training in science communication, including workshop training or certification.

Results

Characteristics of surveyed science bloggers

Survey respondents included only a slight predominance of men, with 57% (n = 345) of respondents being male and 42% (n = 256) being female. This contrasts to previous studies of science bloggers in which male bloggers have significantly outnumbered female bloggers in various blogging niches [Shema, Bar-Ilan and Thelwall, 2012]. Respondents are relatively young: 46% (n = 283) are 18 to 34 years old, 27% (n = 165) are 35 to 44 years old. Despite their young age, respondents are highly educated, with 21% (n = 130) having Master's degrees and nearly 48% (n = 290) having doctorate degrees. Less than 5% of respondents have less than a Bachelor's degree.¹⁴ In terms of degree area, 39% (n = 235) of respondents have a degree in a life science field and 28% (n = 170) have a degree in a physical science field (see supplementary material available online¹⁵).

A notable minority of science bloggers, or 20% (n = 125), identify as students in their current occupational status. A majority of bloggers are employed for wages full-time or part-time, while a minority are self-employed or freelance full-time or part-time (see Table 1). It appears from my data that those bloggers employed full-time are largely employed in academic research. Upward of 47% (n = 288) of respondents identify their primary occupational area as academic research. Roughly 5% (n = 32) identify their primary occupational area as non-academic research, 8% (n = 49) as education, and 8% (n = 50) as science writing. Less than 5% of respondents identify their primary occupational area as journalism, which corresponds with my finding from qualitative interviews that science bloggers rarely self-identify as journalists. Male and female science bloggers who responded to this survey are roughly equally employed in areas of scientific research, journalism and scientific outreach, while a slightly greater percentage of female respondents indicate being employed in the area of science writing. See Table 1 for other survey respondent demographics, broken down by gender.

Of bloggers responding to the survey, 14% (n = 86) indicated that they earn money for their blogging. Approximately 24% (n = 145) indicated currently have a blog editor or someone in a similar role. The average blogging experience across all

¹⁴In terms of degree area, a majority of respondents have a degree in a life science (39%, n = 235) and/or physical science field (28%, n = 170).

¹⁵<http://dx.doi.org/10.6084/m9.figshare.1294153>.

Table 1. Participant Demographics.

Question	Male N (Percent)	Female N (Percent)	Total N (Percent)
<i>Gender</i>	345 (57%)	256 (42%)	610
<i>Age</i>			
18 to 24 years	23 (7%)	32 (13%)	55 (9%)
24 to 34 years	106 (31%)	120 (47%)	228 (37%)
35 to 44 years	113 (33%)	52 (20%)	165 (27%)
45 to 54 years	66 (19%)	29 (11%)	95 (16%)
55 to 64 years	26 (8%)	20 (8%)	46 (8%)
Age 65 or older	11 (3%)	2 (<1%)	12 (2%)
<i>Occupational Status</i>			
Employed for wages full-time	214 (62%)	123 (48%)	337 (55%)
Employed for wages part-time	19 (6%)	19 (7%)	39 (6%)
Self-employed/Freelance full-time	31 (9%)	28 (11%)	59 (10%)
Self-employed/Freelance part-time	19 (6%)	22 (9%)	41 (7%)
Student	51 (15%)	73 (29%)	125 (21%)
Carer	2 (<1%)	7 (3%)	9 (<2%)
Unemployed	11 (3%)	7 (3%)	18 (3%)
Retired	13 (4%)	2 (<1%)	15 (3%)
<i>Highest Degree</i>			
Complete some high school	2 (<1%)	2 (<1%)	4 (<1%)
High school graduate	3 (1%)	3 (1%)	6 (1%)
Some college credit / Associate degree	16 (5%)	7 (3%)	23 (4%)
Bachelor's degree	46 (13%)	43 (17%)	89 (15%)
Completed some postgraduate	21 (6%)	23 (9%)	44 (7%)
Master's degree	70 (20%)	59 (23%)	130 (21%)
Doctorate degree	179 (52%)	111 (43%)	290 (48%)
Professional degree	5 (1%)	5 (1%)	11 (<2%)
<i>Occupational Area</i>			
Academic research	161 (47%)	126 (49%)	288 (47%)
Non-academic research	19 (6%)	13 (5.1%)	32 (5%)
Education	33 (9.6%)	15 (6%)	49 (8%)
Science writing	18 (5%)	32 (13%)	50 (8%)
Journalism	15 (4%)	13 (5%)	28 (5%)
Science outreach	9 (3%)	14 (6%)	23 (4%)
Medicine / Public health	10 (3%)	7 (3%)	17 (3%)

Note: Occupational areas selected by 2% or less of participants include engineering, public/media relations, scientific publishing, and other professional communication or technical writing (grant writing, etc.). A total of 58 participants (9.5%) selected "other" for occupation. For the purposes of this study, occupational area was recoded as research vs. other and science writing vs. other.

respondents in terms of years since one first started blogging, ranging from 0 to 10, is a little over three and a half years (SD = 2.9). Female bloggers tend to have less experience than male bloggers in terms of blogging years, having blogged for an average of three years (M = 2.9, SD = 2.7) compared to male bloggers' four (M = 4.1,

SD = 3.0; $p < .001$). However, female bloggers also tend to be significantly younger than male bloggers ($\chi^2 = 33.6, p < .001$) which may account for their fewer years of experience. Approximately half or 51% of female respondents ($n = 130$) indicated having received science communication training, while 33% ($n = 113$) of male respondents indicated the same.

Self-perceived communication roles

Participants self-reported engaging most frequently in the roles of explainer ('I explain or translate scientific information from experts to non-specialist publics'; $M = 3.92, SD = .95$, on a 5-point scale from never to always) and public intellectual ('I synthesize a range of complex information about science in which I have a degree of specialization and present this from a distinct, identifiable perspective'; $M = 3.30, SD = 1.06$). Engagement in these roles was followed, in terms of overall frequency, by the roles of civic educator, agenda setter and advocate. Figure 1 includes a visual representation of the percentages of surveyed bloggers who self-reported engaging in these various roles either often or always, or rarely or never. Majorities of science bloggers perceive themselves to rarely or never engage in the roles of watchdog, investigative reporter, media critic or convener. See Table 2 for means of perceived engagement in all roles, on a scale of 1 (never) to 5 (always).

Table 2. Means for Perceived Communication Roles, in order of overall frequency with which science bloggers engage in these roles.

Role	Mean	SD
Explainer / Science Communicator	3.92	.95
Public Intellectual	3.30	1.06
Civic Educator	3.11	1.10
Curator	2.87	1.21
Agenda Setter	2.75	1.09
Advocate	2.67	1.22
Media Critic	2.53	1.13
Watchdog	2.35	1.12
Convener	1.95	1.11
Investigative Reporter	1.93	1.00

Role by occupational area

Perceived roles were broken down by primary area of occupation through a series of one-way ANOVA analyses with Bonferonni adjustment for multiple comparisons. Bloggers who identified as professional science writers reported engaging in the role of explainer significantly more often ($M = 4.38, SD = .78$) than did those who identified their primary occupational area as academic research ($M = 3.81, SD = .94$) (Mean difference = .574, $p < .005$; $F = 2.64, p < .01$). This was true for professional science journalists and science writers across the board. Science writers/journalists reported engaging in the role of explainer ($M = 4.27; SD = .78$) significantly more often than did bloggers in all other occupational areas combined ($M = 3.87; SD = .96$). Bloggers who identified as science writers, including freelance science writers, reported engaging more often in the role of explainer than bloggers

How often do you engage in the following role(s)?

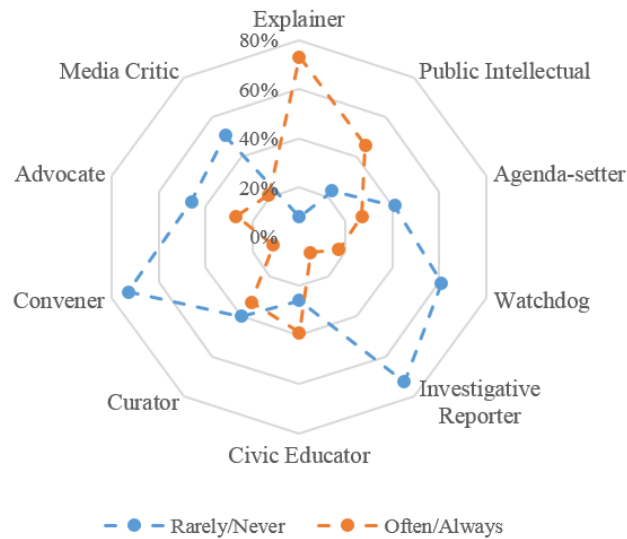


Figure 1. Radar graph of perceived communication role(s), by percentage of respondents who indicate they engage in this role a) often or always (orange) and b) rarely or never (blue). Science bloggers perceive themselves to less often engage in watchdog, convener (connecting scientists and members of the public) or investigative reporter roles.

in other occupational areas even when controlling for age and gender, blog affiliation, blogging experience and science communication training (see Table 3). Journalists reported engaging in the role of investigative reporter significantly more often ($M = 2.43$, $SD = .96$) than did those in the area of academic research ($M = 1.78$, $SD = .92$) (Mean difference = .65, $p = .056$; $F = 3.27$, $p < .001$). This was also true for science writers/journalists across the board, who reported engaging in the role of investigative reporter ($M = 2.21$; $SD = .96$) significantly more often than bloggers in all other occupational area combined ($M = 1.89$; $SD = 1.00$) even when controlling for other factors (see Table 3). Science bloggers who identified as science writers reported engaging more often than other bloggers did in the roles of investigative reporter and explainer, but less often in the role of media critic.

In general, science bloggers in research (academic or non-academic), or roughly half of all survey respondents (52%, $n = 320$), self-reported engaging in most of the science communication roles less often than did bloggers in other occupational areas, with the exception of public intellectual and agenda-setter. This trend in the data suggests that science bloggers who are researchers in their “day job” engage in the act of science blogging with less of a focus on the traditional science communication roles such as explainer, watchdog, investigative reporter, curator and media critic, and with more of a focus on establishing themselves as public intellectuals on particular (academic) topics.

In a series of one-way ANOVA analyses investigating perceived role by science communication training, bloggers with training in science communication self-reported engaging more often in the roles of advocate ($M = 2.81$, $SD = 1.20$ vs. $M = 2.56$, $SD = 1.21$; $F = 6.05$, $p < .05$) and convener ($M = 2.11$, $SD = 1.04$ vs. $M = 1.83$, $SD = 1.04$; $F = 8.88$, $p < .01$) than those with no formal education or training in

Table 3. Univariate Analysis of Variance of Roles by Science Writing/Journalism.

Source	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>	<i>partial η²</i>	<i>R₂</i>
<i>Explainer</i>							
Contrast	1	7.90	7.90	9.04	.003	.015	.032
Error	588	513.70	.87				
Total	595	9702.00					
<i>Investigative Reporter</i>							
Contrast	1	5.25	5.25	5.56	.019	.009	.047
Error	582	549.53	.94				
Total	589	2741.00					

Note: Between groups comparison is between those bloggers who are occupied in areas of science writing or science journalism vs. those occupied in all other areas (e.g. research, education, outreach, professional/technical communication, etc.). Covariates include participant gender, age, total blogging experience in years and blog affiliation (network vs. non-network blog).

science communication. Those with science communication training self-reported engaging in the role of advocate significantly more often than those without such training even when controlling for other factors (see Table 4). Such training, however, had no impact on how often bloggers reported engaging in other communication roles.

Table 4. Univariate Analysis of Variance of Roles by SciComm Education/Training.

Source	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>	<i>partial η²</i>	<i>R₂</i>
<i>Convener</i>							
Contrast	1	11.38	11.38	9.50	.002	.016	.042
Error	578	692.30	1.20				
Total	586	2921.00					
<i>Advocate</i>							
Contrast	1	7.46	7.46	5.17	.023	.009	.032
Within Groups	584	842.29	1.44				
Total	592	5039.00					

Note: Between groups comparison is between those bloggers who are occupied in areas of science writing or science journalism vs. those occupied in all other areas (e.g. research, education, outreach, professional/technical communication, etc.). Covariates include participant gender, age, total blogging experience in years, blog affiliation (network vs. non-network blog), engagement in research (academic or non-academic research vs. other occupation) and engagement in science writing (writing or journalism vs. other occupation).

Role by gender

Gender was also associated with perceived blogging roles. In a series of one-way ANOVA analyses of role by gender, male science bloggers reported engaging in the roles of watchdog and media critic ($M = 2.43$, $SD = 1.11$; $M = 2.64$, $SD = 1.11$) more often than did female science bloggers ($M = 2.22$, $SD = 1.12$; $M = 2.38$, $SD = 1.16$), to a significant degree (respectively: $F = 5.15$, $p < .05$; $F = 8.13$, $p < .01$). Female science bloggers reported engaging in the role of explainer ($M = 4.04$, $SD = .92$) more often

than did male science bloggers ($M = 3.84$, $SD = .95$), to a significant degree ($F = 6.57$, $p < .05$). Gender differences in frequency of engagement in the roles of explainer and media critic remain significant (for explainer) or marginally significant (for media critic) when controlling for blog affiliation, age, education, blogging experience, occupation and science communication training (see Table 5 below).

Table 5. Univariate Analysis of Variance of Roles by Respondent Gender.

Source	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>	<i>partial η²</i>	<i>R₂</i>
<i>Explainer</i>							
Contrast	1	4.16	4.16	4.76	.029	.008	
Error	587	512.33	.87				
Total	595	9702.00					.035
<i>Media Critic</i>							
Contrast	1	4.70	4.70	3.77	.056	.006	
Error	583	727.83	1.25				
Total	591	4537.00					.049

Note: Between groups comparison is between male vs. female science bloggers. Covariates included in models include blog affiliation (network vs. non-network), age, total blogging experience in years, engagement in research (academic or non-academic research vs. other occupation), engagement in science writing (writing or journalism vs. other occupation) and science communication training.

Role by blog affiliation

Through a univariate ANOVA analysis, I investigated blogging roles as a function of blog affiliation. Out of all survey respondents, 71% ($n = 433$) report blogging independently, while 27% ($n = 167$) report blogging for one or more blogging networks. Those not blogging for a blog network tend to be engaged in academia as students or researchers.¹⁶ Thus, it makes sense that bloggers not blogging for a network would report, in general, that they engage in traditional science communication roles less often than do those blogging for a network. When controlling for gender, age, blogging experience and primary occupational area, network bloggers reported engaging in the roles of public intellectual ($M = 3.49$, $SD = 1.04$ vs. $M = 3.23$, $SD = 1.07$), watchdog ($M = 2.59$, $SD = 1.13$ vs. $M = 2.24$, $SD = 1.10$), investigative reporter ($M = 2.23$, $SD = 1.09$ vs. $M = 1.80$, $SD = .92$), convener ($M = 2.17$, $SD = 1.20$ vs. $M = 1.85$, $SD = 1.06$), and advocate ($M = 2.89$, $SD = 1.20$ vs. $M = 2.57$, $SD = 1.21$) significantly more often than did non-network bloggers. However, network bloggers may also blog more often and engage in science communication roles in general more often than non-network bloggers. When also controlling for posting frequency and the average of engagement in all other blogging roles, network bloggers only engage in the role of investigative reporter significantly more often than non-network bloggers (see Table 6).

¹⁶Of respondents who report their primary occupational area as academic research, only 20% ($n = 58$) blog for a network or news organization. Of respondents who report journalism as their primary occupational area, 57% ($n = 16$) blog for a network or news organization.

Table 6. . Univariate Analysis of Variance of Role by Network vs. Non-Network Blogging.

Source	df	SS	MS	F	p	partial η^2	R ₂
<i>Investigative Reporter</i>							
Contrast	1	3.86	3.86	6.13	.014*	.01	
Error	562	354.10	.063				
Total	571	2656.00					.359

Note: Between groups comparison is between those bloggers who blog for networks and those who blog independently or for an 'other' non-network blog (e.g. a group blog). Covariates included in models include gender, age, total blogging experience in years, posting frequency, engagement in research (academic or non-academic research vs. other occupation), engagement in science writing (writing or journalism vs. other occupation), and the average of engagement in all other listed roles.

Exploratory analysis of factors that determine blogging roles

Through a series of linear regression analyses, I investigated other factors that may predict science bloggers' perceived communication roles, and the relative importance of these factors in explaining perceived roles. Factors explored include gender, age, blog affiliation, primary occupation, blogging experience, education, pay, editorial oversight and science communication training (for correlations between factors, see appendix Table 10). Additional control factors include posting frequency and average engagement in all listed roles (AER). Posting frequency was included to control for the fact that some participants may indicate engaging more frequently in particular roles simply because they post blog updates more frequently than other bloggers. The variable for average engagement in all other roles was added to account for the fact that respondents who indicate engaging in a particular role frequently might also tend to indicate engaging frequently in other roles. For example, bloggers who engage often as investigative reporters might tend to see themselves as explainers but tend not to see themselves as public intellectuals, especially if they tend to be trained journalists. Select results are shown in Table 7. Results in text reflect outcomes of regression models including all of the factors listed above.

Blog affiliation with a network and engagement in science writing and/or journalism as one's occupation are significant predictors of self-reported engagement in the role of investigative reporter (see Table 7). Gender and science writing and/or journalism are the only significant predictors of the explainer role. Only gender (being male) is predictive of engaging in the role of watchdog ($\beta = -.08, p < .05; F = 15.24, p < .001; R^2 = .252$).¹⁷ Lower levels of education ($\beta = -.10, p < .05$;) and posting frequency ($\beta = .21, p < .001$) are predictive of the role of curator ($R^2 = .183, F = 10.14, p < .001$).¹⁸ Having training in science communication ($\beta = .12, p < .01$) is predictive of the convener role ($R^2 = .194, F = 10.93, p < .001$).¹⁹ Gender (being male) ($\beta = -.08, p < .05$) and occupation outside of science writing ($\beta = -.12, p < .01$) are predictive of the role of media critic ($R^2 = .345, F = 23.83, p < .001$).²⁰ Being a researcher by occupation ($\beta = .14,$

¹⁷If AER removed: $F = 3.64, p < .001; R^2 = .066$.

¹⁸If AER removed: $F = 5.70, p < .001; R^2 = .1$. Education and posting frequency remain significant predictors.

¹⁹If AER removed: $F = 3.84, p < .001; R^2 = .07$. Scicomm training remains significant predictor.

²⁰If AER removed: $F = 4.24, p < .001; R^2 = .076$. Scicomm training remains significant predictor.

Table 7. Significant regression model results for perceived role.

	Models	R ²	F	β
<i>Investigative Reporter</i>		.358	25.23***	
		(.092 w/o AER)		
	Gender			-.04
	Age			-.03
	Blog Affiliation (Network vs. Indep./Other)			.09*
	Occupation (Research vs. Other)			.003
	Occupation (Writing vs. Other)			.09*
	Blogging Experience			.01
	Pay (paid or unpaid)			-.02
	SciComm Education/Training			.01
	Education			-.04
	Editorial Oversight (editor or not)			.02
	Posting Frequency			.06
	Average Engagement in all other Roles (AER)			.55***
<i>Explainer</i>		.095	4.76***	
		(.038 w/o AER)		
	Gender			.10*
	Age			.03
	Blog Affiliation (Network vs. Indep./Other)			-.03
	Occupation (Research vs. Other)			-.04
	Occupation (Writing vs. Other)			.10*
	Blogging Experience			.02
	Pay (paid or unpaid)			.03
	SciComm Education/Training			.04
	Education			-.04
	Editorial Oversight (editor or not)			.02
	Posting Frequency			-.05
	Average Engagement in all other Roles (AER)			.25***

Note: *** $p < .001$, ** $p < .01$, * $p < .05$. Moderate positive correlations (≥ 0.4) exist between blogging affiliation and pay (Pearson Coefficient = .43, $p < .01$) and blogging affiliation and having an editor (Pearson Coefficient = .49, $p < .01$). If we remove the pay and editor variables to avoid correlated regression factors, blogging affiliation remains a significant predictor for the investigative reporter role, and all significant factors above remain significant for the explainer role. If we remove only the variable for average engagement in all other roles, the regression models remains significant, blogging affiliation remains a robustly significant predictor for the investigative reporter role, and gender and occupation remain significant predictors for the explainer role.

$p < .01$) predicts self-reported engagement in the role of agenda-setter ($R^2 = .264$, $F = 16.23$, $p < .001$).²¹ Regression models for public intellectual, advocate and civic educator roles have no significant predictors other than average engagement in all other roles.

²¹If AER removed from model: $F = 2.85$, $p < .01$; $R^2 = .046$. Occupation remains significant predictor.

Blogging Approach. Across the board, science bloggers I surveyed use a translational/explainer approach most frequently, followed by editorial and curation approaches in creating blog content (see Table 8 for means and standard deviations).

Table 8. Means for blog approach, in order of overall frequency with which science bloggers use each approach in their blogging.

Approach	Mean	SD
Translational/Explainer	3.84	.89
Editorial	3.39	.92
Curation	2.94	1.15
Analysis	2.77	1.11
Journalistic	2.22	1.11

In a series of linear regression analyses, I investigated how blogging approach depends on a variety of factors including blogger demographics (gender, age, blogging experience in years), occupational area, blog affiliation, blog pay, education and science communication training (for correlations between factors, see appendix). These factors combined explain a significant portion of variance for curation, journalistic and analysis blogging approaches. The results for the journalistic approach to blogging are shown in Table 9 below.

Table 9. Significant regression model results for the journalistic blogging approach.

Models	R ²	F	β
<i>Journalistic</i>	.211	17.04***	
Gender			-.05
Age			-.03
Blog Loc (Network vs. Indep./Other)			.13**
Occupation (Research vs. Other)			-.05
Occupation (Writing vs. Other)			.21***
Blogging Experience			.06
Pay			.10*
SciComm Education/Training			.18***
Education			-.16***

Note: *** $p < .001$, ** $p < .01$, * $p < .05$.

The following factors predict using a journalistic approach to blogging: blogging for a blog network, being a science writer/journalist by primary occupation, having science communication training or education, being paid to blog, and having relatively lower levels of education (below a doctorate degree) (see Table 9). The relationship between blogging for a network and using a journalistic approach to blogging is driven partially by having a blog editor,²² where bloggers writing for blog networks overseen by blog editors are often employed by science news organizations such as *Scientific American*, *National Geographic*, etc.

²²When including a dichotomous 'blog editor' variable in the regression model in Table 9 predicting use of a journalistic approach to blogging, this variable becomes a significant predictor ($\beta = .14$, $p = .002$) and blog affiliation is no longer a significant predictor ($\beta = .08$, $p = .08$). Having a blog editor and blogging for a blog network are significantly and positively correlated, Pearson Correlation = .49, $p < .001$).

The following factors predict using a curation approach to blogging ($R^2 = .051$, $F = 3.39$, $p < .001$): younger age ($\beta = -.12$, $p < .01$), engagement in occupations other than scientific research ($\beta = -.11$, $p < .05$) and relatively lower levels of education ($\beta = -.11$, $p < .05$). For an analysis approach to blogging ($R^2 = .033$, $F = 2.13$, $p < .05$), only gender is a significant predictor ($\beta = -.14$, $p < .001$), with male science bloggers more likely to conduct analysis in their blogs (for example, solving everyday physics problems with original calculations or approximations) than female science bloggers.

While the overall regression model as described in Table 9 above was not significant for the translational/explainer blogging approach ($R^2 = .02$, $F = 1.47$, $p > .05$), gender was also a significant predictor, and the only significant predictor, for that blogging approach. Female science bloggers were more likely to indicate using a translational/explainer approach in their blogging than male science bloggers ($\beta = .1$, $t = 2.23$, $p < .05$). None of the individual factors investigated in Table 9 above significantly predict use of an editorial approach to science blogging. It appears a wide swath of science bloggers, regardless of blog affiliation, occupation and other demographic factors, engage in this blogging approach, presenting their opinions as well as factual information on current issues and events.

Discussion

This study reveals that bloggers engage in similar communication roles as science journalists in new media environments [Fahy and Nisbet, 2011].

However, bloggers also engage in these roles to different extents depending on their primary area of occupation, blog affiliation, training in science communication and gender. Science bloggers self-report engaging most frequently in the roles of explainer, public intellectual and civic educator. Reflecting previous research findings [Fahy and Nisbet, 2011; Ranger and Bultitude, 2014], science bloggers herein report most frequently explaining science understandably to non-specialists. In this capacity, science bloggers are overlapping in their perceived roles with professional science journalists. However, we see this overlap more for bloggers who are writers and/or journalists in their day jobs, as they report engaging in the role of explainer more often than bloggers in other occupational areas do. This makes sense, as translation of scientific research is a staple of paid science writing. However, this study also reveals that science bloggers across the board, not just professional writers, see themselves engaging frequently in this role. To the extent that scientists who blog see themselves engaging in the role of explainer, science blogs have indeed become a “natural venue for popularizing science and engaging with the public at large” [Blanchard, 2011, p. 224]. Blogging to translate science has implications for the form and function of science blogs. Bloggers who see themselves engaging in this role should avoid jargon and relate scientific research to the average reader through engaging writing and storytelling. Bloggers who engage in this role likely rely on published scientific research, and to be effective should be highlighting the meaning of this research to non-academics.

The gap between the roles of scientists and science writers/journalists in the blogosphere becomes wider when we consider the role of investigative reporter and a journalistic approach to blogging. Science writers/journalists report engaging in the role of investigative reporter significantly more often than bloggers in other occupational areas do, where the gap is especially large for journalists vs.

academic researchers. In parallel, network bloggers report using a journalistic approach in their blogging significantly more often than non-network bloggers. This is likely because bloggers at news organization blog networks such as *National Geographic's* Phenomena are socialized into established norms and rules of journalism in selecting and producing blog content [Spyridou et al., 2013; Jarreau, 2015]. In contrast, on the broadest level participants in this study report least often using a journalistic approach to their blogging. Independent science blogs appear to have largely *not* replaced journalism [Brown, 2014; Brumfiel, 2009; Domingo and Heinonen, 2008], even if blogging roles and journalistic roles do overlap among certain groups of bloggers. This evidence supports a media ecology view of blogs vs. other media formats in the news ecosystem [Anderson, 2013]. Science blogs largely don't replace science journalism, but they may add more explanation, context, analysis or expert opinions where such is missing from other media [Domingo and Heinonen, 2008].

This study is significant in showing that science bloggers with different day jobs (e.g. research vs. journalism) see their communication roles differently. The fact that science bloggers see themselves engaging in communication roles that overlap but compliment more than compete with the roles of science journalists [Fahy and Nisbet, 2011] helps to explain why blogs have not replaced science journalism [Brumfiel, 2009]. Bloggers' self-perceived communication roles depend on occupation, science communication training and blog affiliation, among other factors. For example, while Fahy and Nisbet [2011] found that the science journalists are generally hesitant to use the term "public intellectual" to describe their communication roles, science bloggers herein report often engaging in this role, second only to the explainer role. Researchers in the blogosphere perceive their communication roles to prominently include the public intellectual and agenda-setter roles, highlighting scientific complexity from an identifiable perspective and bringing attention to topics they feel are under-reported in the wider science media ecosystem. In an age of politicized debates around scientific issues, scientists may be experiencing a social responsibility to step into the blogosphere to draw attention to under-reported scientific issues, overlooked aspects of public debates over science [Dudo, 2015], or topics they are passionate about. Professional science writers and journalists on the other hand are not regularly rewarded for engaging in the roles of public intellectual and agenda-setter, which require time and scientific expertise, even if their engagement in these roles is on the rise. It is bloggers who see themselves as reporters and who use a more journalistic approach to their blogging who tend to write for networks hosted by news organizations. Having formal science communication training also predicts using a journalistic approach to blogging. This has implications for science communication training for those bloggers without an education in mass communication or a similar field, e.g. many scientists. By adopting a more journalistic approach to their writing, or engaging more as explainers, scientists may be able to bring their content to blogging networks and news outlets with increased reach as a result.

Training in science communication is also significantly related to self-reported engagement in other particular communication roles. Bloggers with training in science communication report engaging more often in the roles of advocate and convener than do those without such training. This may be because science communication workshops and seminars are often geared toward improving

communication skills with the goal of promoting public understanding and attitudes toward scientific issues such as climate change. Such training may also increase bloggers' awareness that connection and dialogue between scientists and non-scientists are important components of effective science communication [Trench, 2008], thus the emphasis on the convener role. Such training, however, has no impact on how often bloggers reported engaging in other communication roles. Follow-up research should focus on how science communication training may shape or shift bloggers' perceived communication roles.

Bloggers surveyed here generally saw themselves only sparingly engaging in the roles of media critic or watchdog. This is a notable finding especially for the role of watchdog, not so much because we would expect science bloggers to have the resources to engage in this role, but because it is a role that is also not regularly engaged in by many science journalists either [Fahy and Nisbet, 2011]. This presents a problem, because if neither science journalists nor bloggers are regularly engaging as watchdogs, who *is* engaging in this important role? To add to the problem, there was a large gender gap in self-perceived engagement in this role. Male science bloggers in this study report engaging in the roles of media critic and watchdog significantly more often than do female science bloggers. Male bloggers have generally received more attention and web traffic than have female bloggers [Meraz, 2008]. For these and other reasons, male science bloggers may feel more confident in their ability to watchdog and critique science and/or the media, or receive more positive attention for doing so. Non-network bloggers are also more likely than network bloggers to engage in the role of media critic, perhaps because editors discourage media criticism as compared to the creation of original content. Future research should focus on identifying the factors that may hold female science bloggers back from engaging in watchdog [Hanitzsch and Hanusch, 2012] and/or media critic roles, especially if science blogs are to be a key source of critical analysis of scientific research and/or media coverage of science. Those who do engage in watchdogging of science and/or the media, for example Health News Review and Retraction Watch, might encourage more of such activity in the science blogosphere and highlight female science bloggers who are engaging in such activity.

Finally, while this study found that self-perceived communication roles and blogging approaches often vary depending on bloggers' occupational area, blog affiliation and gender among other factors, other blogging characteristics are prevalent enough across all bloggers to be considered norms of the blog format. Among the science bloggers surveyed for this project, the translational/explainer and editorial approaches to creating blog content were most common, in that order. The editorial approach to blogging did not vary significantly across any factors investigated in this study. The blog as a format, with the editorial freedom it typically comes with, invites all blog authors to mix their opinions and personal perspectives with their writing on scientific topics. This characteristic sets science bloggers apart from professional journalists writing for more traditional formats, for whom objectivity and impartiality are more salient norms. Science bloggers are generally engaged to at least some extent, and often to a large extent, in synthesizing complex information about science and presenting it from a perspective informed by their personal expertise and expert opinions. Future research on the impacts of science blogs might focus on the public intellectual role

and the editorial approach to blogging, for example to see if bloggers are engaging in this role effectively and if this role is reflected in people's motivations to read/use science blogs.

Limitations and future directions

This study used a large and diverse sample of science bloggers to investigate their self-perceived communication roles. However, this is only a first step in revealing the perceived communication roles of science bloggers and the impact of these roles on content. The sample of science bloggers investigated, although large and diverse, is still non-representative and of unknown exact geographical distribution (although broadly distributed in the U.S. and European countries). A rather significant limitation of this study is that bloggers were not prompted to answer an open-ended question about what other roles they engage in. Such a qualitative analysis of blogging roles and practices is left to be the subject of forthcoming research by the author. However, apart from engaging in the role of a researcher sharing his/her own work (which could be argued to fall under a public intellectual role), the roles explicated by Fahy and Nisbet [2011] appear to overlap extensively with the roles of science bloggers, even if relative engagement in these roles differs for science bloggers who are scientists vs. journalists for example. Preliminary research did not reveal that other significant roles should be added to the list of roles included in this study based on Fahy and Nisbet's typology. However, future research should investigate whether science bloggers are engaging in different or new roles from those investigated here.

This study is also limited in that the investigation of bloggers' roles was limited to self-reports. A follow-up study is underway to investigate whether the readers of these blogs perceive the blog authors to engage in similar roles, to similar degrees, as the blog authors self-report. Future research might also analyze a cross-section of the posts of these same science blogs to determine roles actualized through content.

Conclusion

We can now begin to visualize science bloggers' roles on a broad level and how blogs fit into the larger science media ecosystem. From their perspective, science bloggers are most frequently engaging as explainers, public intellectuals and civic educators. The explainer role is dominant for both science writers/journalists and scientists who blog, while scientists who blog tend to report engaging relatively more frequently as agenda-setters and public intellectuals. This finding at first seems self-explanatory, but it has significant implications for the public reach of these different groups of science bloggers and how they fit in or compliment the larger science media ecosystem. It also has implications for how we might address attention or accessibility gaps between science writers who blog and scientists who blog, e.g. providing science communication and journalistic training for scientists. However, science scholars and scientists in the blogosphere are engaging more heavily as agenda-setters and public intellectuals. This likely puts pressure on professional science writers to do the same, or to at least pay attention to the deeper and more contextualized or intellectual treatment of science news in the blogosphere.

Appendix A. Correlations between regression factors

Table 10. Pearson correlation coefficients between factors often included in regression analyses in predicting various science blogging practices in Chapter 4.

Factors	2	3	4	5	6	7	8	9	10	11	12
1 Sex	-.18**	-.02	.12**	.02	-.21**	.02	.18**	-.06	.03	.05	-.12**
2 Age		.09*	.02	-.14**	.37**	.06	-.04	.25**	-.05	-.11**	.12**
3 Blog Location			.11**	-.17**	.23**	.43**	.06	-.04	.49**	.08*	.35**
4 Science Writing				-.40**	.01	.27**	.10*	-.09*	.09*	-.04	.15**
5 Science Research					-.10*	-.28**	-.09*	.24**	-.17**	-.01	-.16**
6 Experience (yrs)						.20**	-.08	.21**	.08*	-.04	.31**
7 Pay							.03	-.06	.39**	.10*	.47**
8 Scicomm Training								-.002	.12**	.01	-.07
9 Education									-.02	.01	.12**
10 Editor										.27**	.33**
11 Multiple Authors											.12**
12 Page-views											

Note: ** $p < .01$, * $p < .05$. Moderate correlation coefficients (≥ 0.4) are in shown in bold. Dichotomous factors (0, 1) include sex, blog location (network vs. non-network), science writing by occupation, science research by occupation, pay, scicomm training, editor and multiple authors. All other factors are scale variables.

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