A Community of (Hybrid) Practice: Identifying the Cultural Influences of Journalism, Academic Extension and Blogging Within the External PLOS Blogs Network

By

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A COMMUNITY OF (HYBRID) PRACTICE: IDENTIFYING THE CULTURAL INFLUENCES OF JOURNALISM, ACADEMIC EXTENSION AND BLOGGING WITHIN THE EXTERNAL PLOS BLOGS NETWORK

ABSTRACT

This study aimed to explain the cultural practice of an online science communication environment called the External PLOS Blogs Network (EPBN). Specifically, this study explains the EPBN's practice as a consequence of three main cultural influences—journalism, academic extension and blogging—which have converged in the Network and seeded a hybrid practice.

Through an analysis of blog network content and interviews with blogger, the EPBN was characterized as a practice-based community. The Network's practice integrates norms from the three aforementioned science communication subcultures. It also merges a combination of technical structures and social dynamics that are typically considered to be anachronistic.

The findings contribute to the body of literature that addresses online science communication processes, where the amount of empirical studies is currently limited. Further, the chracterization of the EPBN serves to contrasts dominant assumptions about the progressiveness of communication through new media technologies. The Network relies equally on traditional practices (from mainstream media and academia) and contemporary practices (from the blogosphere) to support a community of science-minded individuals.

CHAPTER 1: INTRODUCTION

Conversations about 21st century science communication have broadly addressed how the Internet is transitioning (or has already transitioned) relevant practices from their 20th century form. The practices associated with the 20th century have been well documented in numerous theoretical conversations, historical criticisms, and empirical studies. By contrast, 21st century practices have a considerably smaller of body of literature. The motivations, dynamics and consequence of this new era of science communication practices has been conceptualized, but leading assumptions in this area have not been thoroughly studied.

In the U.S. science communication has traditionally been an institutionalized practice. The majority of Americans in the 20th century received their scientific news through mainstream media sources, particularly print and broadcast media. This trend reached its peaked in the time period starting from the late 1970, when the *New York Times* began its regular science news section, through the 1980s, when the demand for popular science made relevant newspaper sections, magazines, documentaries, and television programming extremely profitable for media publishers and producers.

At this time, science communication was initiated and controlled by a small population, scientists within the formal scientific community (e.g. academic and government research institutions) and science journalists within the mainstream media. These individuals maintained the respect of the rest of society due to their extensive levels of scientific education and significant professional experience with science. They also maintained a close working relationship with each other, which allowed them to insulate scientific information and negotiate when and how that information would be released to the lay public. Their access to science and

their control over its visibility in society made it easy for them to exclude the lay public from being active in the process of communicating science.

Theoretically, science communication in this form is known as the 'deficit' or 'transmission' model of communication. This model is considered to be a translational exercise between scientists, journalists, and lay citizens. In this conception, scientists and journalists are seen as the sole science experts in society and the gatekeepers to the formal scientific community, whereas the members of the lay public are seen as ignorant about science and potentially hostile to its advancement. Scientists and journalists transmit information 'downstream' in various capacities (typically through some form of mainstream media) to fill a 'deficit' in the lay public's knowledge, with goal of building their understanding and enthusiasm for science.

The deficit model has been contested since the late 1990's, when social and communication scholars began to reconsider the validity of an ignorant and hostile public, in addition to the idea that scientific information in society could only move passively and in one direction. These shifts in perspectives coincided with the emergence of Internet culture, which has since made sweeping and dramatic changes in how people communicate across all cultural spheres.

The Internet's ascendance to cultural ubiquity in the 21st century has coincided with a number of changes that have affected the traditional infrastructure of science communication. Most obvious has been the disintegration of the formal institutions that have historically served to bridge the formal science community to the public. The past decade has seen an overall decline in Americans' utilization of print (with newspapers suffering the most) and broadcast media. This is especially true for younger Americans who have grown up with the Internet. A

2010 survey by the National Science Board (as cited by Scheufele, 2013) found that Americans were about equally likely to rely on the Internet and television as primary source for news about science and technology (35% and 34%, respectively). More than two-thirds of Americans (59%) used the Internet as their primary source to learn about scientific issues (the survey specifically asked about global warming and biotechnology).

As a result, traditional media organizations are now employing fewer full-time science journalists, and scientists are now utilizing fewer traditional media outlets to disseminate their work to the public. These individuals are increasingly moving to new environments, particularly online, to maintain the science-public interface. The vastness of the Internet and ambiguity of its still developing spaces brings new complexities to science communication as it shifts into what it is generally considered to be its contemporary practice.

This shift has been frequently discussed and there are leading assumptions about what online science communication represents and how it functions. The "grand narrative of science communication" (Trench, 2007) that dominates relevant conversations has presented the online environments are opportunities to create a more open scientific community, where members of the lay public can have increased access to scientific information. Further, because many online technologies (in particular, social media websites) facilitate socialization across geographic bounds and two-way discourse, these conversations have presented the online environments as opportunities to challenge the supposed "deficit" model.

Specifically, relevant opportunities have emphasized the importance of public engagement with science and technology. Although there are various approaches to the relationship between science and society, "public engagement" is primarily concerned with dialogue opportunities between scientists, science institutions and the lay public (AAAS, 2014).

In this context, a wide range of interested stakeholders are thought to interface and have bi-directional discourse about how science and technology affects daily life.

The public engagement approach is thought to be beneficial to both all stakeholders, where they can participate and meaningful discourse and learn from each other. To date, there has been little empirical research about online science communication to validate those claims. The lack of data has allowed optimism to overinflate conversations about how science is communicated in online environments, so critical analyses are needed to ground or counter these perspectives.

The case study that follows explains how two traditional subcultures of science communication, journalism and academic extension, and one contemporary century subculture of science communication, blogging, have converged in an online space and seeded a hybrid practice.

The online space of interest is a prominent science blog network. Blogs are essentially an open diary-like website where readers can provide feedback to authors in the form of comments. They are also defined by their interactivity, multimodality, and user-friendliness. Because of these characteristics, blogs have become a popular form of communication across cultural spheres, most notably politics and entertainment. In these genres, the blog platform has supported relationship-building and mobilization among like-minded individuals without mediation from media or government entities.

With respect to science, blogs have slowly but steadily grown in presence and influence in the 21st century. The first science blogs were dismissed by many scientists and journalists, who were overwhelmingly concerned about how blogs lowered the barrier of accessibility to publishing. They felt that amateur involvement in science communication would only

perpetuate the amount of scientific misinformation and biased scientific viewpoints that were released to the public. Lay citizens that blogged about science at this time were generally not taken seriously as science communicators, due to their lack of credentials and experience. Similarly, early blogging scientists and journalists were outcasts in the formal scientific community and many blogged under pseudonyms to preserve their professional reputations.

Science blogging has become more socially acceptable due to prominent scientists having major successes with the blog platform, like Paul Meyer (Pharyngula), Bora Zivkovic (A Blog Around the Clock), Ed Yong (Not Exactly Rocket Science), as well as prominent print journalists like Deborah Blum (Speakeasy Science/Elemental). The "celebrity status" of these individuals brought legitimacy to science blogging and encouraged individuals inside and outside of the formal science community to adopt the blog platform as a means of participating in science communication. A strong indicator of the science blog explosion is the site ResearchBlogging.org. Since its creation in 2007, it alone has registered over 1,200 blogs dedicated to scientific peer-reviewed research (cited in Brossard, 2013).

Now, blogs are often touted as the hallmark of 'modern' science communication. Blogs have been celebrated for their potential to diversify and democratize the science-public relationship. Those who currently blog or advocate blogging believe that the lack of editorial oversight (from the mainstream media and the formal scientific community) means that blogging holds great potential to contribute to broader and more engaged science-minded society.

To date, there has been almost no empirical evidence to validate this potential. Kouper (2010) has conducted the most in-depth examination of science blogs, a content analysis of 11 sites. She ultimately determined that her data was too heterogeneous to for her to characterize the science blog genre.

To further complicate matters, science blogs and science blogging have become increasingly difficult to define due to the recent trend of mainstream media organizations co-opting the blog platform. In the past five years, established media brands like *National Geographic*, *Wired* and *Nature* (which in the 20th century were popular in their print formats) have launched blogs and blogs network in an effort to build their respective online presences. This appropriation has also occurred in other blog genres, but for science it forces a peculiar reconciliation of communication practices due to the interfacing of the formal scientific community, mainstream media, and the blogosphere, where as a consequence tenured research scientists, graduate student researchers, policy makers, educators, journalists, advocates, and lay citizens and others now can each serve as informants of science.

In my study, I've identified three aforementioned science communication subcultures as influences on hybrid practice that exists in science blog network. This blog network is associated with the Public Library of Science (PLOS), a mainstream-level research publishing organization. The External PLOS Blogs Network represents a number of tensions in the shift between 20th century and 21st century science communication. Almost all of the blogs in this network are authored by insiders of the formal science community, like tenured research scientists, advanced graduate student researchers, and medical professionals, and also elite science journalists, like editors or prominent news editors and award-winning writers. Bloggers outside these institutions are severely underrepresented.

At the same time, the External PLOS Blogs Network is constructed around digital media technologies and is patronized by those who utilize the blog platform in various capacities. PLOS has a public mission statement that emphasizes its dedication to being a progressive enterprise and the organization is a vocal ally in the open access science movement. The

External PLOS Blogs Network is publicized as being "independent." PLOS publically advocates open discourse about science in its blog network and maintains that all content is published without its editorial oversight.

I characterized the External PLOS Blogs Network as a practice-based community, using Etienne Wenger's (1998) community of practice (CoP) model as a theoretical lens. Through a content analysis of blog content (posts and comments) and interviews with bloggers, I was able to identify the technological structures and social dynamics of the blog network. I then was able to determine three essential dimensions of its community practice: (1) The types of participants in the community and the ways in which they mutually engage with each other (2) The joint mission, or goals, that the community's participants have cultivated and adhere to over time (3) The shared repertoire, or resources, that the community's participants have created and utilize to mutually engage with each other and pursue their joint mission.

The findings suggest that the External PLOS Blogs Network is equally traditional and contemporary, and it is building a unique hybrid practice that integrates cultural strands from the three aforementioned subcultures. From journalism, the blog network borrow a culture of professionalism and a hierarchical structure among participants; from academic extension, the blog network borrows guiding principles of long-term outreach goals; from blogging, the blog network borrows its technological infrastructure and its relevant opportunities. To solely represent this blog network as contemporary would be inaccurate. However, it still serves to push current boundaries of science communication and stretch the roles participants in certain capacities.

CHAPTER 2: REVIEW OF LITERATURE

Overview

In what follows, I review the literature that informed the present study and justified its research. First, I summarize the conceptual frameworks that have been associated with 20th and 21st century science communication. Second, I describe the three science communication subcultures of interest to this study— journalism, academic extension and blogging—using the theoretical and empirical knowledge available in each area. There I explain how the social and institutional boundaries encapsulating those subcultures have eroded over the past two decades, and how this has created the potential for hybrid practices that violate the traditional-modern dichotomy. Third, I offer a synopsis of the External PLOS Blogs Network and give reasons as to why I approached it in my study as a space of hybrid practice. Lastly, I present the questions I investigated in my research.

Models of science communication

Conversations about science communication tend to revolve around the interactions of three groups of actors: science experts, meaning individuals or institutions that are professionally affiliated with the science community or highly knowledgeable about a science domain; the lay public, or the part of society that lacks formal science education or training; and science journalists, who have historically served as mediators between science experts and the lay public.

The leading conceptual framework that explained early interpretations of science literacy and science participation is commonly referred to as the *deficit model* (or *diffusionist model*) of communication. In this model, communication is asymmetrical and flows one way, from science experts (individuals or institutions) to a public that lacks science expertise. Bucchi (2008) summarizes the key assumptions of this model:

- The media functions to communicate scientific ideas, but is often hindered by a lack of competence and the influence of private/commercial interests
- The public is passive and comprised of individuals who, by default, are scientifically illiterate and hostile towards science. These obstacles can be overcome via effective science communication.
- Science communication is a linear process between two distinct groups: a scientifically literate source ("experts") to scientifically illiterate recipients ("publics"). Communication is a one-way process in which only experts influence publics.
- Communication is a process concerned with the transfer of knowledge from experts to publics.
- Science information is seamlessly transferred from one context to another, from the scientific community to the general public, without any significant changes to core ideas in the content.

The deficit model was developed in the late 1980's, in tandem with the public understanding of science movement occurring in the United Kingdom (Burns, 2003). At the time, science

communication scholars and practitioners were primarily concerned with educating the public, which they assumed would occur if science information was simply given to individuals.

The phenomenon at the center of the deficit model, knowledge gaps between science experts and nonexpert audiences, has been studied by communication scholars in the field of health and political communications since the 1970s (Scheufele, 2013). This body of scholarship has largely informed the field of public understanding of science (PUS), a term which field researchers have taken to having dual meaning. According to Bauer (2006) PUS can represent "a wide range of activities that aims to bring science closer to the people and promotes PUS in the tradition of public rhetoric of science," while also representing "social research that investigates, using empirical methods, what the public's understanding of science might be and how this may vary across time and context."

These studies have demonstrated that the public's science literacy is the outcome interplay of individual and social processes that are more complex than just providing access to scientific information. In particular, examinations of diverse learners have demonstrated the deficit model may exclude certain social- and individual-level factors that may facilitate learning (Sturgis & Allum, 2004). Data from the National Science Foundation (NSF) (2008, 2010) has shown that higher educated people (i.e. having a B.S. or higher) are more likely to engage with informal science information sources that their less educated counterparts--for example, from 2006 to 2008, science museum attendance rose 6% (from 37% to 43%) among highly educated U.S. citizens, compared to a consistent 8% of the least educated citizenry during the same period. Data has also shown that highly educated individuals are more able to extract information from media and community sources than their less educated counterparts. This has been reflected over time with respect to public health-related information consumption and more recently with

information consumption related to emergent science like nanotechnology (Scheufele, 2013).

These studies have also shown that there is a complex relationship between the public's science literacy and their acceptance of science, or have at least failed to demonstrate that there is positive linear between the two (Dunwoody, Brossard & Dudo, 2009). The statistical relationship between knowledge levels and acceptance has been shown to be issue dependent, with the weakest correlations being attached to controversial and emerging sciences (Bauer, 2006). It has also been shown that the literacy-acceptance relationship is dependent on a number of other variables, including deference toward scientific authority, trust in scientists, issue involvement and levels of knowledge surrounding the political infrastructures in which science is debated (Scheufele, 2013).

These findings highlight that assuming that information accessibility is the only requirement for science literacy or acceptance limits the scope of PUS work in its efforts to understand public science literacy. It has been argued that applying the deficit model to science expert and nonexpert interactions may result in distorted interpretations of each party's participation of the science communication process. Because of this, in the late 1990s, scholars revisited the deficit model and reevaluated its appropriateness for modeling science communication. Sturgis and Allum (2004) summarized the central criticisms of the model, specifically that the deficit model is flawed because it implies the following:

- Science information is a neatly contained package that can be delivered easily and linearly
- One-way information flow, from specialized to popular contexts, is the only possible mechanism of communication.

- The participants of the science communication process fits into idealized roles, where science communicators play the role of social and professional mediators of science; science experts are authorities of science information, but are extraneous to the process of science communication, and; members of the lay public have no role in the production or communication of science
- The members of the lay public are ignorant about science and possible hostile towards the advancement of science in society, but that effective science communication can result in their general understanding and acceptance in this area.

As a consequence, the past fifteen years have brought models of 'modern' science communication that have reconceptualized the science communication process as more complex and participatory relationship between science and society. Instead 'empty vessel' conception, these models consider the lay public to be active in handling science information and capable of constructing their own meanings from science communication.

Collectively, these models have done much to fuel what is known as the public engagement with science (PES) movement. In addition to the burgeoning literature, the PES movement is also comprised of widespread interest--from the science, government, educational and nonexpert communities--in activities (e.g. public forums, museums, citizen science) which seek public involvement in science and science policy (Powell & Colin, 2008). The practice of public engagement is broad, encompassing a range of activities, events, projects and programs with diverse outcomes and goals. As a consequence, there have been numerous suggested conceptualizations of "public engagement".

Chief Executive Officer of the American Association for the Advancement of Science

(AAAS) Alan Leshner (2003) has described public engagement as a necessary "convergence" between science and society that moves away from what he called a "paternalistic stance" of of science experts to a "partnership" with nonexpert audiences. Acknowledging that the barrier to such a partnership is not just a lack of comprehension, Leshner (2006) has cited bidirectional dialogues as a key mechanisms for engaging the public in scientific concerns, saying "...scientists need to have a real dialogue with members of the public, listening to their concerns, their priorities, and the questions they would like us to help answer. We also need to find ways to move science forward while adapting to their legitimate concerns."

Other have suggested the public engagement is not a means to an end, like dialogue, but the end goal itself. For example, it has been suggested that public engagement should be measured by their links to hard policy outcomes or societal deliverables, or by the extent to which the impact the coproduction of new knowledge (Bucchi & Neresini, 2007; cf. Callon, 1999; Lehr et al., 2007, as cited in Davies, 2010).

Public engagement has also been presented as an all-encompassing framework that takes into account all levels of the public's participation in science, including non-participation. Rowe and Fewer (2005) conceptualize public engagement at three levels, in terms of interactions between "sponsors" (meaning the party initiating communication and/or engagement, typically a science expert or institution) and "public representatives" (meaning nonexpert publics): (1) Public communication, which represents communication where information flows one way from sponsors to public representatives (2) public consultation, where information is conveyed by public representatives to sponsors, but only after engagement is initiated by sponsors, and (3) public participation, where there is formal and meaningful dialogue between the two groups.

To date, "public engagement" remains discursively flexible term, with no one typology or conceptual framework being commonly adopted (Hansen, 2006). This has led to a lack of clarity with respect to the desired goals and outcomes of PES practices. Certain public engagement activities, like science cafés, focus groups, scenario workshops, deliberative polls, and citizen juries, have been conceived and executed by citizen participation organizers with clearly defined goals; however, evaluations of engagement activities to have suggested that these needs more articulation about the broad goals of organizers and sponsoring institutions within this movement (Powell & Colin, 2008).

Cultural shifts in science communication

Journalism

Science journalism is a specialized practice that serves as an intermediary between the internal scientific community and the public sphere (Trench, 2008a). Traditionally, in America, science journalism has been practiced within the institutional structure of the mainstream media, with print and broadcast media being the lay public's main sources of scientific news (Nisbet et al, 2002). Science journalism was a successful business enterprise for mainstream media throughout the 20th century, but it "boomed" starting in the late 1970's, when *The New York Times* created a science section (Rensberger, 2009). It's estimated that, in the late 1980's and early 1990's, around 100 American newspapers had regular science sections, and this was accompanied by a nationwide upsurge in science magazine sales (Brumfiel, 2009a; Rensenberg, 2009).

Historically, science journalists have been professional writers and communicators who have obtained significantly more field-related experience than their generalist peers (Murcott, 2009). This was considered to be a necessary qualification for the job, as journalists require adequate scientific training to translate primary data and reports into understandable language for nonexpert audiences. For most of the 20th century, the profile of an American journalist working in the mainstream media was typically white and male; in 1992, women comprised about 34% of journalists, while ethnic minorities represented about 8% of the field (Weaver & Wilhoit, 1992). Within that, science writers tended to be older and more formally educated than their generalist peers (Shoemaker & Reese, 1996a). Because of this, science journalists were more similar to the cultural elite than then general public.

Throughout most of the 20th century, science journalism was considered by communication scholars to conceptually fit to the deficit model. Scientists, journalists, and members of the lay public embodied distinct identities: Scientists were the science experts, and the primary producers of scientific information. Science was assumed to be neutral source of authority, and their findings were assumed to be truthful and free of the influence of political or social values. Seldom did members of society question this authority or criticize science as a structural system; conversation of scientific dilemmas, were usually attributed to individual-level error or unfortunate happenstance.

Journalists were the primary interpreters and translators of scientific information (Trench, 2008b). In their role, journalists served as boundary-minders between the scientific community and the public, and this allowed them to be "the principal arbiters of what scientific information [entered] the public domain and how it [did] it" (Trench, 2007, p141). This gave journalists "privileged" status that enhanced the authority of scientists and the prestige of science

institutions (Fahy & Nisbet, 2011).

Because of the roles, scientists and journalists were active participants in the process of knowledge creation (Murcott, 2009). This reinforced strict ideas of which individuals could be considered science experts and which individuals could be considered credible sources of science information (Cunningham-Burley, Kerr & Tutton, 2007). This excluded the members of the lay public, who acted as the primary consumers of scientific information.

To regulate the power dynamic between the three groups, their interactions have traditionally been guided by a code of professional standards and ethics. This code was derived by mainstream media culture and has been maintained to helped journalists and their sources navigate the various challenges and tensions involved with news production (Nelkin, 1995b). Specifically, the code exists to help journalists self-monitor their work and, when possible, avoid conflicts of interest.

This code is a broad and socially enforced ethical system, and there are unique standards to each subgenre of journalism. However, most professional journalists value (or are taught to value in their training) the principles of truthfulness, accuracy, objectivity, impartiality, fairness and public accountability (Shoemaker & Reese, 1996b). Often, a particular news organization, group, and association have their own set of professional guidelines that individuals must adhere to maintain employment of membership.

For example, the Society of Professional Journalists (SPJ), the largest professional journalist association with approximately 10,000 members (SPJ, 2014), abides by a formalized code of ethics that emphasizes the following publishing standards from its members: (1) 'Seek the truth and report it," meaning that journalists should be honest, accurate and fair in gathering, reporting and interpreting information; (2) "Minimize harm," meaning that journalists should treat sources, subjects and colleagues

with respect; (3) "Act independently," meaning that journalists should be free of obligation to any interest other than the public and their right to be informed; and (4) "Be accountable," meaning that journalists are accountable to their readers, listeners, viewers and their professional peers.

In practice, maintaining a code of ethics can be challenging for media organizations and their journalists. Some critics have argued that, even with a code of ethics, the likelihood of journalists being biased or acting in their own favor when working is great, and that it is too difficult for them work independently of their ideologies; others have suggested suggest that journalists consciously bias their news reports in line with their personal attitudes (Shoemaker & Reese, 1996b). One subgenre of journalism, advocacy journalism, is perhaps the strongest departure of the field traditional standards and ethics, as journalists within in this form as offered considerably more room to openly flex their personal beliefs, attitudes and values their reporting (Allan, 2011).

Historically, science journalists have been tasked with the challenge of upholding journalistic ethics while also reporting science in ways that make it readable, interesting and marketable to broader audiences. Because of this, science journalists has to frequently evaluate where and when it was appropriate to subjective value into their reporting, and to what extent.

Dorothy Nelkin (1995b) introduced the concept of journalists "selling" science to the public to conceptualize how the press has navigated that process. She credited the founders of science journalism, particularly those involved with organizing of [the first science news syndication service] the Science Service in the 1920s. These men, "shaped by both perceptions of public tastes and the values and concerns of the scientific community, created a market for science news and a pattern for the emerging profession of science journalism" (p.83).

This often meant that to "sell" science, journalists would have to professionally compromise and inject human interests in their reporting, emphasizing drama, conflict or danger

to appeal to the cultural spirit of the times. For example, in the1930s and 40s, science journalists utilized a "gee-whiz" style of reporting, which emphasized the wonders of sciences to persuade the war-panicked public that science was the salvation of society (Lenwenstein, 1992). This promotional style had resurgence in the 1980s, when reports on science and technology leaned to conservative business mentality of the Reagan administration (Rensberger, 2009). By contrast, environmental movement of the 1970s inspired many science journalists to step into a "watchdog role" and be more critical of scientific developments (Rensberger, 2009).

The media infrastructures that supported the traditional identities, ethics, and norms of science journalism have deteriorated in the 21st century. This is largely due to significant collapse of print and broadcast media as business enterprises. The magazine *Business Insider* proclaimed 2009, "the year the newspaper died" due to the number of newspapers that reduced staff and production time to adjust to shrinking audiences (Dumpala, 2009). In 2012, *Newsweek* magazine announced that it would cease publishing its print editions and move to an all-digital format, which was a major signal that the print magazine business was failing (However, it reinstated its print format in 2013.) (BBC News, 2014). Television news has also become vulnerable as viewers now utilize local and cable news less frequently than they did in the 1990s and early 2000s (Pew, 2012).

The downturn in print and broadcast media has been accelerated by the rise of online information consumption. In 2006, it was reported that 7 out of 10 Internet users go online to look up the meaning of a scientific term or to ask a question about a scientific concept of theory (Horrigan, 2006, as cited in Anders, Brossard, Scheufele, 2009). At the same time, the user are also search for more nuanced content particular to specific scientific fields or aspects of scientific research (Brossard, Scheufele, 2009).

To adapt, mainstream science media has shifted online. Established science media brands like *National Geographic*, *Wired*, *Nature* and *Popular Science* all have digital components, like websites and e-zines, to accompany their print publications (Allan, 2011). At the same time, science journalism has expanded beyond the bounds of the mainstream media structure. It has become more common for science journalists to self-publishing though personally-owned online spaces like websites, blogs, and social media (Fahy & Nisbet, 2011).

As a consequence, science journalism is a more fractured practice than it was in the 20th century that involves more heterogeneous group of active participants. Scientists, government organizations, higher education institutions, non-profit groups now utilize various forms of online media to contribute their ideas about science into the public sphere; lay citizens have shifted out of the role of information consumers and are also more vocal and visible in science communication (Brown, 2009). While all of those individuals are not properly known as science journalists, they are more frequently performing the duties that are associated with the science journalists (Borchelt, 2009).

In addition, Internet technologies have offered possibilities in communication that didn't exist through traditional media sources in the past, i.e., hypertextuality, interactivity, and multimodality (Brossard, 2013). Individuals can now publish rich online content that is enhanced with visual and audio media (Eliperin, 2009). They can also bring their audiences in direct contact with their source materials, though linking to research articles and eternal websites (Cooper, 2010; Machill, 2011). This process of science journalism is more labor intensive, but it creates potential for content that is more contextualized and facilitates greater transparency in published work.

The majority of discussions about online science journalism have presented it as a broader-reaching, busier, less formal and less linear practice than its 20th century predecessor (Isabella, 2004). This fits with the "grand narrative" of science communication that has accompanied the rise of Internet culture, which asserts that the one-way, top-down model of science communication has lost its dominance (Trench, 2008a). Discussions that have emerged within this narrative frame 'modern' science journalism as a participatory and collaborative practice, acted out by individuals inside and outside of the scientific community, with diverse levels of scientific experience and expertise (Bucchi, 2004).

Further, it has been argued that those individuals do not fit any rigid conceptual roles and operate within a strict model of communication (Meyer, 2006; Nguyen, 2006; Bucchi, 2009). Rather, they are thought to be dynamic in the process of science journalism, where they act in roles interchangeably and at the same time, and move reactively among each other, being active creators, translators, and consumers of scientific information. Similarly, their collective actions are no longer assumed to serve one particular function in society. Instead, it is thought that they serve a variety of journalistic functions simultaneously such as informing, persuading, education, critique, and investigating.

Academic extension

The practice of academic extension in United States is largely indebted to the Morrill Land Grant Act of 1862, commonly referred to as the first Morrill Act (the second was enacted in 1890). The Association of Public and Land-Grant Universities (APLGU) offers a comprehensive historical account of land-grant universities (LGUs) in their handbook *Land Grant Traditions* (2012): Sponsored by Vermont senator Justin smith Morrill, the first Morrill

Act was enacted in order to provide federal support to states that created public education institutions served the working class. There are now more than 100 LGUs in the country, and they exist in every state. Traditionally, those universities have offered classical studies, but have emphasized practical education and focused on the areas of agriculture, engineering, and mechanical arts.

The first Morrill Act required all of its funded universities to create and maintain agricultural experiment station programs to conduct research. In order to disseminate data and research findings from those programs, the Smith-Lever Act of 1914 was enacted to provide ongoing funding to cooperative extension services across the land-grant system. Those services have since aimed to connect LGUs to targeted audiences.

According to the APLG (2010), cooperative extension services at LGUs typically focus on educating and empowering individuals in surrounding urban and rural communities who have ties to professional fields such as farming, horticulture, animal husbandry, forestry and water conservation. The overarching goals of those services are to promote civic and social responsibility in the communities by encouraging leadership, citizenship and public engagement, while also providing opportunities for economic growth by providing the communities with marketing and economic tools.

Since the enactment of the Smith-Lever Act, the practice of cooperative extension has expanded beyond LGUs. Extension services have become fixtures of academic culture and a present at a wide range of university and college types (Ramussen, 2010). In the late 1990's, the Kellogg Commission on the Future State of Land Grant Universities coined a name for academic institutions involved with extension: "engaged universities" (McDowell, 2003). Similar to LGU

practices, academic institution that are "engaged" promote translational research and seek ways to build positive and practical relationships with the greater communities around them.

With the opportunities that accompany online technologies, extension services have become increasingly multi-faceted and interactive in the 21st century. For example, Vanderbilt University (a small, private, non-land-grant research institution) has the Vanderbilt Center for Science Outreach that supports faculty members that want to implement or evaluate Broader Impact Activities, which are informed by criteria set by National Science Foundation. In addition to community-based programs and activities, the Center uses a combination of print materials (like pamphlets, fact sheets and quarterly magazines), a dynamic website with multimedia plugins and social media to promote the translational research of the university. The Center is guided by the vision statement "Science is for All Americans." Its goal is to strengthen the relationship between the scientific and education communities, while also bridging the two to the lay public.

Extension services like Vanderbilt's have become a crucial component of 'modern' engaged universities. STEM-oriented departments use media tools and strategies share research findings outside of peer-reviewed field journals (Jensen & Holliman, 2009). It is common for science programs and departments within academia to hire communication specialists or enlist a full communication staff to function as in-house newsmakers and public relations agents (Brumfiel, 2009a). This allows universities to circumvent the mainstream media when needed and present their research to publics more directly (Holliman, Collins, Jensen, & Taylor, 2009).

"Science 2.0" has been the general term used to describe this evolving media culture among STEM fields within academia (Nattkemper, 2012; Stuart, 2012). Scientists at the forefront of

Science 2.0 advocate openness and connectedness with external publics not only when findings are published, but at every stage of the research process (Hove, 2012). In addition, some scientists and critics of science culture feel that the scientific community should operate through a "glass door" in which science-related discourse, gatherings, and decision-making are conducted with greater transparency (Burgleman, 2010).

Science 2.0 has been especially marked by the trend of academic research scientists participating outreach communication through social media (Koenneker, 2013). Particularly, personal blogs and the "microblogging" website Twitter have allowed scientists to share themselves, their work and information about their respective field with the greater public (Gunter, 2014). As with journalism, those web tools can facilitate fast, direct and interactive connections between scientists and targeted audiences, and this could potentially serve more efficient and effective translation of scientific work.

The Science 2.0 perspective challenges scientists to practice outreach communication with even greater autonomy and reach than afforded before. Scientists within this "movement" are encouraged by their peers to co-opt duties that traditionally have been the responsibilities of academic extension program (Hove, 2012). For example, "live reporting" on Twitter by scientists is now an acceptable activity of scientists attending conferences and other major field events (Brumfiel, 2009b). Also, blogging scientists have used their websites to announce recently published works, like articles and book chapters, in addition to relying formal press releases (Wild, 2010). In a sense, activities like these allow scientists to serve as their own informal public relation agents, and they give audiences more intimate exposure to the scientists and their insights.

The emergence of media savvy universities and research scientists suggests that, like journalism, university extension is gradually becoming a more expansive and fractured practice within science communication. Scientists that participate in individualized outreach within the online spaces are increasing the number of pathways that audiences have to academic research and scientific expertise. As a consequence, these pathways are slowly inviting new participants, more contingencies, and greater fluidity into the practice.

Blogging

A blog is a continuously updated personal web page with short articles (called "posts") that are presented in reverse chronological order. Posts are typically written in an informal style using "I"-centered narratives, and are followed by reader feedback in the form of commenting (Davidson & Vaast, 2009). Because of the platform's format and interactive capability, blogs are often conceptualized as open, online diaries (Kouper, 2008).

Blogs have been around since the late 1990s, but have since increased exponentially in terms of social presence and influence. In 2006, the blog site Technorati stated that it was trafficking more than 57 million blogs; in 2008, the same site estimated 133 million blogs (Sifry, 2008). In April of 2013, Tumblr alone showed that it had 101.7 million registered blogs; and other sites like Wordpress and Live Journal had 67 million and 62 million registered blogs, respectively (Snitchim, 2013).

Blogs tend to be topical and based on the personal or professional interests of bloggers. Science-themed blogs are one such genre within the blogosphere. It has been estimated that there are 1,000-1,200 science blogs, but that number has been difficult to verify (Trench, 2012). In relevant discussions, there has yet to be a consensus on the definition of science blogs, but

they are commonly described as blogs that focus on a scientific discipline or areas such as food, medicine, technology, and the environment (Batts, 2008). Science bloggers also have a broad profile range. Science bloggers are often tenured academic researchers, post-doctoral researchers and graduate students, or science journalists and science writers, and science-minded members of the lay public (Wilkins, 2008).

Bora Zivkovic, a chronobiologist and blogger, who is widely considered within the scientific community to be the "Blogfather," attempted to delineate what is and isn't a science blog in his July 12, 2012 post, "Science Blogs – definition, and a history":

> "What is considered a science blog varies, and has changed over the years. Usually it is meant to be a blog that satisfies one or more of those criteria: blog written by a scientist, blog written by a professional science writer/journalist, blog that predominantly covers science topics, blog used in a science classroom as a teaching tool, blog used for more-or-less official news and press releases by scientific societies, institutes, centers, universities, publishers, companies and other organizations." (Zivkovic, 2012)

There are examples in literature to support Zivkovic's definition. Science blogs have been used as classroom instruction tools (Glassman, 2013), public teaching tools (Merbern, 2013; Souder, 2012), reflective research logs (Thorsen, 2013), draft logs for upcoming textbooks and scientific publications (Hodgson, 2011), as outreach tools by scientific research centers and scientific departments of higher education institutions (Shanahan, 2011), and news information outlets (Colson, 2011). In each of those contexts, the blog has a unique set of authors, content, and functions. However, despite the lack of conceptual cohesion, science blogs are generally

considered to be tools for facilitating open and informal dialogues about science with various publics (Trench, 2012; Zivkovic, 2012).

With respect to the outreach conception, the dominant perception of blogging throughout science communication literature is that the practice can serve as a virtual bridge between the formal scientific community and the rest of society, and potentially help make science more accessible and palatable to the masses (Shanahan, 2011). It's been hypothesized that blogs challenge the deficit model by facilitating two-way communication between science experts and readers (Trench, 2007). Similarly, blogs have been presented as spaces where voices traditionally marginalized by the mainstream media can contribute their thoughts, ideas, and criticisms to scientific discourses (Walejko & Ksiazek, 2010). It's also been suggested that, when used effectively, blogs could facilitate collaborative learning and decision-making pertaining to science issues (Batts, 2008; Wilkins, 2008).

Empirical evidence to support this conception is limited. The initial attempts to study science blogs have been broadly guided by the goal of better understanding how the blog platform facilitates public engagement with science (the public generally defined as individuals who are not professionally associated with a scientific discipline). Collectively, this body of research is scant and has presented mixed characterizations of the relevant genre.

Kouper (2010) content analyzed the posts and comments of eleven highly trafficked blogs that discussed science and technology. She hypothesized that for science bloggers to utilized the blog platform as a "mode of [public] participation" they needed to "1) inform their readers about scientific news, 2) explain complicated matters in a manner understandable by a lay person, 3) evaluate research findings and claims made by others, 4) articulate their position toward controversial issues." From her findings she suggested that science blogs at the time had

a “multiplicity of forms” and were too heterogeneous to characterize. Even though each of the sampled blogs advertised itself as science-focused, the bloggers showed great variability with respect to their background, topic selections, sourcing patterns, writing style, approaches to engagement, and readership demographics. Further, she argued that the science blogs “present a challenge rather than an opportunity” due to the lack of genre conventions if audiences couldn’t attach any levels of expectation or certainty to their interactions with the bloggers or content.

Trench (2012) reviewed twenty “top-ranked” science blogs (many of the same blogs overlapped with Kouper’s study) to establish support for his earlier suggestion that Internet technologies were “turning science communication inside out” (2008) and opened the public’s view to the scientific community. His findings showed “great diversity” in the frequency of updates, sourcing patterns, and topic selection. Beyond that, he found that less than a quarter of the blogs attempted to take readers “behind the scenes of science” and those that did focused on obtuse areas of disciplines. He concluded that, overall, there was little evidence in his sample to support the claims that blogging played significant role in communicating science to the public.

Masters (2013) explored that practice and perceptions of science bloggers though twenty in-depth interviews and review of blog content. His findings also showed that bloggers utilized a wide variety of writing processes, but that they are similar motivations (in this case, they mostly blogged for recreation) and the ability to infuse the writing with personality. However, in contrast to Kouper and Trench, he suggested that science blog could be useful engagement tools. Specifically, he found that the bloggers were responsive to readers and willing to converse with them through comments. Further, he argued that blog characteristics like hyperlinking, post updating and content correcting “help enhance accuracy” of science communication.

Two studies (Fausto et al, 2012; Sheman, Bar-Ilan & Thelwell, 2012) specifically sampled from the aggregator Research Blogs (RB). Sheman, Bar-Ilan and Thelwell found consistencies across their samples of one hundred twenty-six blogs: (1) bloggers showed a preference for papers from high-impact journals and blogged mostly about research in the life and behavioral sciences and (2) most of the bloggers (90%) has active Twitter account associated with their blogs and relied heavily on other forms of social media to facilitate connectivity with readers. Fausto et al, in their much smaller study (twelve blogs), found that Twitter was also an integral component to the blogs in their sample. However, he was less optimistic about the potential of the genre than the authors of the complementary study saying, "The emergence and rise of more recent online technologies and services based in social media tools such as Twitter may mean that blogs, one of the oldest digital platforms, are losing ground in numbers."

Due to the limited and mixed data to explain science blogging as a practice, there has been resistance to fully accepting blogs as a reputable source for scientific news and information. It has been argued that the way to combat this issue is to make blogging more "professional" and mold the practice after established form of science communication, particularly journalism (Lasica, 2003). Bloggers that support this viewpoint have adopted more journalistic practices as to increase credibility and trust with people inside and outside the scientific community.

Blog networks have been created in an attempt to bring consistency and credibility to the practice. Although there is no precise definition of a blog network, it is typically considered to be a group of formally associated and similarly-themed blogs (Zivkovic, 2012). Blog networks have been established for a several blog subgenres, including fashion, sports, politics, food, and music. These networks are typically associated with or endorsed by an established media brands (Garber, 2010).

The first major science blog network, ScienceBlogs, was founded in 2006 and managed by Seed Media Group (SMG). The networked served to connect and promote science bloggers, and also make it easier for interested readers to locate quality science blogs (ScienceBlogs, 2013). At its peak in 2009, ScienceBlogs hosted 75 blogs from various field of scientific research, and several of its bloggers were award-winning science writers and prominent active scientists. Science Blogs originated as an "independent" blogging network, meaning that the content published by bloggers was not influenced by political or institutional loyalties (Appell, 2010). Allowing space for unfiltered scientific discourse is what largely attracted bloggers and readers and drove traffic to the network.

In June 2010, SMG decided to alter the format of ScienceBlogs and allow "institutional" blogs—authored by employees of the Brookhaven National Laboratory, Weizmann Institute of Science, Search for Extraterrestrial Intelligence Institute (SETI), European Council for Nuclear Research (CERN), and Howard Hughes Medical Institute to join the network. Additionally, SMG also added "Food Frontiers," a blog sponsored by Pepsi-Cola Corporation to the network, stating that the blog would focus on the health and nutritional aspects of the company's products (Vince, 2010).

These changes angered many of the network's bloggers and readers, who felt that true editorial independence could not be maintained alongside corporate and institutional ties. They were especially outraged over the addition of "Food Frontiers" because they felt that Pepsi's sponsorship would ultimately damage the integrity of the network. As a result of this, many of ScienceBlogs's bloggers left the network and its readership plummeted. The incident, now referred to as "Pepsigate," sparked a debate about the intent of science blogging and the raised questions about the degree to which the genre should become institutionalized (Alok, 2010).

Out of the implosion of ScienceBlogs came other science blog networks that were owned by established media companies, groups, and organizations. Brands such as *National Geographic*, *Wired*, *Public Library of Science*, *Nature* and *Popular Science* each have their own blog networks. Similar to ScienceBlogs, these networks capitalize on the reputations of their blogging scientists and science writers (Mason, 2013). *Wired*, for example, advertises the bloggers in its network as its "All-Star Bloggers." (Wired, 2013)

Science blogging culture emerged outside the structure of the mainstream media, partially in effort to promote discourses and ideas that were not (or could no longer be) supported within the traditional science journalism structure. To some, it seems counterintuitive that the mainstream science media would appropriate blogging, or that science bloggers would want to align with mainstream media (Crotty, 2013). Still, established media brands and independent science bloggers are more frequently choosing to collaborate because blogs are an inexpensive and far-reaching way to reach readers. As mainstream media brands continues to migrate online, blogs represent a cost-effective way for them to remain relevant to publics that obtain much of their news online (Cann, 2013).

The partnership can be mutually beneficial. Davidson and Vaast (2009) found that "A-list" technology bloggers used their connections to the mainstream media and high-profile tech companies to gain access to insider information and a broader visibility for their work. Beyond that, those connections helped the bloggers gain legitimacy and be perceived as having the same ethical standards as their affiliated media brands. Lui, Lui, Rousseau, and Yang (2012) produced similar findings when they analyzed Chinese science blogs and concluded that the impact of a blog is linked to the status and reputation of the blogger, and having mainstream media ties could help bloggers drive traffic to their websites. Colson (2011) argued that, to be

successful, science bloggers need to balance their independence with pragmatic interconnectedness to the mainstream media. She said, "If science bloggers compete to disseminate science news, they need to be as serious and rigorous as journalists."

Blog network were addressed directly when the 8th World Conference of Science Journalist (WCSJ) convened in June 2013 in Helsinki, Finland. Among other plenaries, sessions and workshops, a group of well-known and respected bloggers and blog editors came together for a panel discussion titled, "The rise of the science blog network: Lessons from the all corners of the world." The panel was moderated by science writer Deborah Blum. Also included were science writer were Ed Yong, whose blog Not Exactly Rocket Science is hosted by *National Geographic*; Betsy Mason, the science editor for Wired.com; Bora Zivkovic, the blogs editor at *Scientific American* and organizer of the Science Online Conference; and Alok Jha, a science correspondent at the Guardian newspaper and presenter of the podcast Science Weekly. They used the forum to examine ways in which professional blog networks impacted their practice.

Yong's, who started blogging in 2006, gave remarks that provided insights on the divide between blogging and journalism:

> "When I started blogging, I was completely independent. …It was a very different time for science blogs back then, none of the networks that the four of us represent existed then...It was a time when blogs were still sort of a weird niche hobby that existed on the fringes of the media. It was quite hard to get respect and credibility for blogs as a medium of quality writing. It seemed like every week, someone like me or Bora would get into a fight about whether blogs could actually contain high quality journalism. The 'blogs vs journalism' thing went on and on and on..."

He then described current perceptions of science blogging:

> "I'm glad to say that things have changed a lot in five years. I don't really have those arguments anymore, and when I do they're noticeable for how rare they are. Those people from before now have their own blogs. And it's become abundantly clear to me certainly and I think everyone that science blogs are now hosting some of the best science writing around. Blog seems so ingrained, so central now. So many different organizations, including the big media names we four represent, have their own networks. Blogs have become this haven for science journalists, both new and established, to cut loose and flex their own writing muscle. And I think the blogs that have joined these networks have become to journalism very serious partners."

Yong still considers his work to be blogging and not journalism, even within the structure of *National Geographic*, one of the oldest and most esteemed brands in mainstream media. However, Yong acknowledged a paradox in his work as a mainstream science blogger—that, as a consequence of blogging within the confines of the mainstream media and seeking the visibility and credibility associated with that institution, his blogging practices as a consequence, have naturally began to mimic the traditional journalism practices. He said:

> "What we're [bloggers] trying to protect is good and reliable and accurate without having to rely on traditional editorial safety nets that we use in the rest of our work. …But now that blogs are part of the mainstream media and becoming increasing ingrained in it, one of our main concerns should be trying to avoid the very same mistakes that we originally arose to fight against…. As my own blog has developed, my methods have become more and more journalistic to the point that now my process for writing a blog post and my

process for writing a new piece for another outlet are completely indistinguishable. I do the same things: I interview people, I get outside comments—It's exactly the same except the writing style is a bit looser and more personal on my own blog."

Yong's remarks support the idea that (at least part of) the practice of science blogging is emerging within cultural and institutional layers of complexity. It may be more logical to now consider science blogging within the same context as mainstream science journalism instead of being an alternative. Within this this framework, it would be easier to explore how science journalism practices are being appropriated for online contexts. Similarly, it would help determine what extent science blogging practices are becoming 'traditional' or "modern."

Cultural hybrids

Based on the previous literature, the present study was guided by knowledge of three major shifts within science communication:

- Due to increasing fragmentation of the media landscape, journalism is currently a far less institutionalized practice than it was in the 20th century. Because of this, there are now opportunities for journalism to be practiced outside the mainstream media, particularly in online spaces, and this introduces new technologies, participants, and functions into the practice of science journalism.
- Due to the increasing influence of Science 2.0 culture, academic extension is now a more individualized practice than it was in the 20th century. Using web technologies, researchers can circumvent extension programs managed by their respective academic institutions and speak directly with targeted audiences. With respect to STEM fields, this renegotiates aspects how outreach is conducted.

- Due to an internal push towards professionalism, blogging is a more institutionalized practice than it was when it emerged at the turn of the century. Specifically, science blogs are starting to integrate with mainstream media and science blogging is becoming affiliated with science journalism. As a result, pockets of the science blogosphere, like blog networks, have become more exclusive and reputable communities than others.

To summarize, the study assumed two contrasting shifts within science communication: that journalism and academic extension are becoming less centralized and institutionalized, while blogging is becoming more centralized institutionalized. However, as all three practices operate partly or fully online (specifically, utilizing new and social media technologies), revolve around the same archetypes of participants (experts, translators, and audiences), and have the same broad goals (to disseminate scientific information to target audiences), it seems likely that the three practices would overlap and influence each other, and lead to hybrid practices.

The External PLOS Blogs Network: A cultural hybrid

The External PLOS Blogs Network (from now on referred to at the EPBN or the Network) is a group of science blogs associated with the Public Library of Science (from now on referred to as PLOS). The EPBN was selected for this study because it has structural and social ties to journalism, academic extension and blogging. Those ties present an opportunity to examine the Network as a mixed cultural practice. Specifically, there are known characteristics about the technology, participants, and guiding principles of the Network that align with the aforementioned shifts in science communication:

- The EPBN is home to blogging science writers from traditional print media, who are publishing independently outside of their home institutions.
- The EPBN has a professional affiliation with PLOS, a prominent academic publishing company that seeks to make scientific research accessible to the masses. In addition, the Network is home to blogging research scientists, health professional and science educators who are publishing independently about their fields outside of their respective home institutions.
- The EPBN has a digital technological infrastructure, the blog platform. In addition, the Network connects these blogs in a centralized, shared space that serves as an extension of the PLOS brand.

To summarize, the EPBN was assumed in the study to be a consequence of journalism, academic extension, and blogging practices converging. Figure 1 illustrates these assumptions.

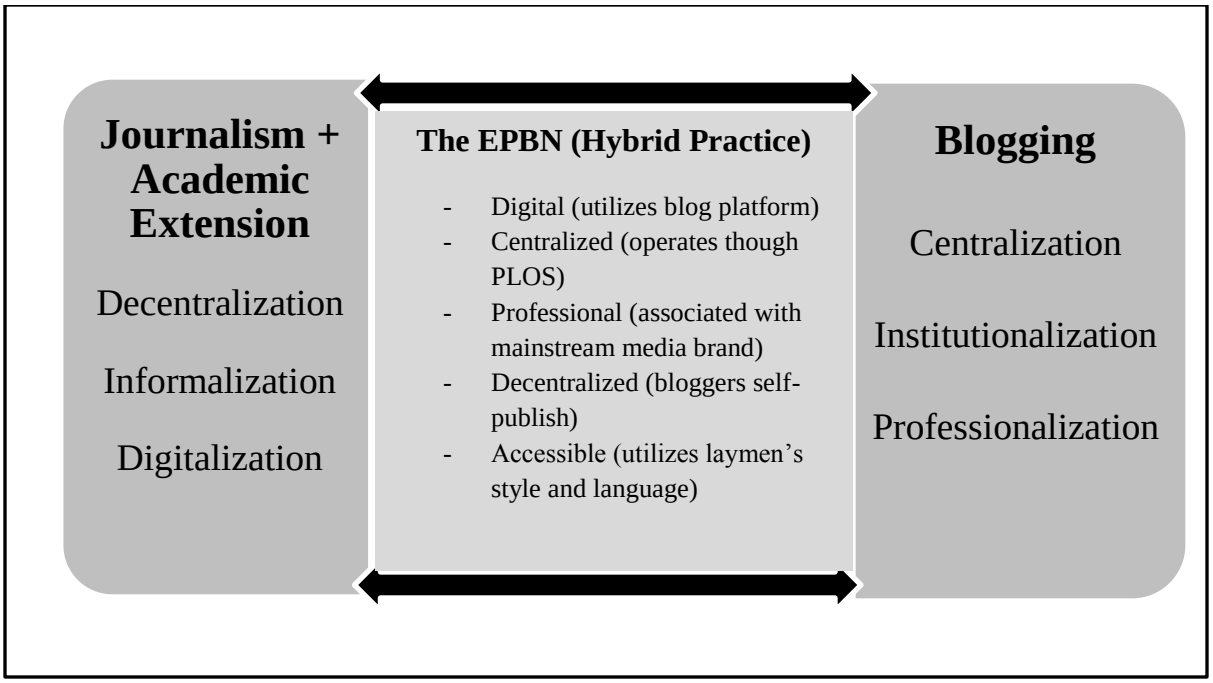

Figure 1. The EPBN as an assumed space of hybrid practice

Research questions

The questions explored in the study are as follows:

- RQ 1: How does the practice identified in the EPBN compare to that of journalism?
- RQ 2: How does the practice identified in the EPBN compare to that of academic extension?
- RQ 3: How does the practice identified in the EPBN compare to that of blogging?
- RQ 4: How does the EPBN function as a space of hybrid practice?

CHAPTER 3: METHODS

Community of interest and participants

The EPBN is a group of interlinked blogs that is associated with the Public Library of Science (PLOS). PLOS is not a legacy media brand; however, it is an established and respected publishing organization that has risen to mainstream status over the past decade. The Network identifies as a progressive enterprise, and it promotes that it is "leading a transformation in research communication." The EPBN is unique from PLOS's other publishing initiatives in that the organization recognizes it as "independent." It is comprised of blogs authored by journalists and scientists who write about scientific research, scientific news and popular science, among other things.

The community was considered to be the blog network as a whole. At the time of the data collection, there were twenty-two blogs in the Network. PLOS organizes its blogs into four categories, based on the interests or expertise of the blogger(s): (1) "ECO" blog are authored by researchers in the fields of ecology and environmental sciences, (2) "HEALTH" blogs are authored by medical doctors and researchers in the field of epidemiology, virology, and population health, (3) "NEURO" blogs are authored by researchers from various fields in the cognitive (brain) sciences, and (4) "CULTURE" blogs are authored by science writers and science educators who addressed issues relevant to science communication, science education, and the public's engagement with science.

At the time, there were two 'archived' blogs, and, in both instances, the bloggers had made a decision to leave the network prior to the start of this study, but allowed their previous

posts to remain available on the EPBN. Also, there was a "Guest Blog" intended to feature the thoughts of rotating guest contributors selected by PLOS, although it had been inactive for months.

The participants were the EPBN's bloggers, commenters and readers. The bloggers were a small, fixed, identifiable group of science writers and scientists appointed by the PLOS organization. By contrast, reading/commenting was open access to everyone, and could be done anonymously or under a pseudonym. Because of this, a large percentage of the participants were in flux and most contributors could not be traced or fully identified.

Data collection

This study used two primary sources of data: the blogs themselves and interviews with the respective bloggers. At the time, the EPBN contained 25 blogs. All of the published posts and comments from these blogs from a six-month period, between January 1, 2013 and June 30, 2013, were captured for analysis. Four blogs were "dormant" during this time period and were excluded from the analysis: the two archived blogs, the Guest Blog and the "CULTURE" blog, MIT SciWrite. A total of twenty-one blogs was monitored via an RSS feed and blog posts, and comments were downloaded and saved in the event that they were edited or deleted. The final data reviewed consisted of 264 posts and 798 comments.

The interviews were conducted with bloggers via Skype (skype.com) during the spring of 2013. Individual bloggers were first contacted via email and asked if they would be willing to be interviewed. The participation rate for those willing to be interviewed was 35%, or a total of 15 bloggers. The interviews followed a semi-structured protocol where bloggers were asked to

discuss: (1) their motivations for starting to blog and their goal(s), (2) the composition of their blog readership and their relationship with their readers/commenters, and (3) their blogging habits and the commenting habits of their readers.

Appendix A summarizes the data collected: (1) the blogs in the EPBN and (2) the bloggers who were interviewed. Also described are the questions used during the interviews.

Analytical methods

Overview

This study's analytical methods were informed by the work of Vanessa Dennen, an information systems scholar who has extensively studied how the blog platform supports online communities. Overall, her work has demonstrated that blog communities develop in two ways: (1) when people with like interests meet on blogs and form an online connections, and (2) when people with real-life connections purposefully create blogs to facilitate collaboration in pursuit of shared goals.

Specifically, this study analyzed data using procedures set by Dennen (2006, 2008, 2009) in her characterization of "Blogadame," a large academic blog network. Using data comprised of blog content and interviews with bloggers, she characterized Blogadame as a practice-based online community, using the Community of Practice model (Lave and Wenger, 1991; Wenger, 1998; Wenger, McDermott and Snyder, 2002) as a theoretical lens. By using this model, she was able to provide insight into: (1) how Blogadame formed, (2) the norms that developed within the community and (3) why its bloggers engaged in their practice.

Theoretical framework 1.1: Preexisting structures

The current study applied Dennen's two-step procedure for analyzing Blogadame to the EPBN. As with Blogadame, my analysis of the EPBN examined trends and themes across the blogs. First, data was analyzed thematically to identify the structural elements and social dynamics of the blog network. This step was informed by previous studies of online community practice (Baym, 1998; Josefsson, 2005).

Five structural elements were identified. Listed below is a brief overview of each:

- *External context:* Reflects the general online environment in which the community is situated (e.g. the media culture, the physical web space), such as preexisting technical and social practices (e.g. commenting, hyperlinking), group relevant resources brought into the online community (e.g. field specific knowledge or skills), and access to the technology

- *Temporal structure:* Reflects the possibility to communicate synchronously or asynchronously, the ability to receive feedback, and the ability to re-write, edit and archive content

- *System infrastructure:* Reflects the configuration (e.g. platform or software), flexibility, compatibility (e.g. frequent plugins) and user-friendliness of technology

- *Group purposes:* Reflects the basic purpose(s) of the community (e.g. group

mission) and the purpose(s) that emerges through the interactions of the participants (e.g. short- and long-term projects and goals)

- *Participant characteristics:* Reflects the diversity of the participants relevant to social status, geographical location, age, gender, ethnicity, education, and experience with technology use, etc.

Theoretical framework 1.2: Social dynamics

Also, four types of social dynamics were identified. Listed below is a brief overview of each:

- *Forms of expression:* Reflects the use of communication style, language, jargon, jokes, and nonverbal social cues unique to the community
- *Identity:* Reflects how a participant develops a name" for himself or herself within the group (e.g. becomes "famous" in the group), or remains anonymous
- *Relationships:* Reflects how relationships (weak and strong) are developed and maintained, and also how offline relationships can transfer offline and vice versa
- *Behavioral norms:* Reflects the social behaviors that are acceptable in the community, and the technical rules that govern this behavior (i.e. "netiquette")

Taken together, the structural elements and social dynamics are indicative of an online community (Baym, 1998; Dennen, 2006; Josefsson, 2005). Early notes were taken by hand and formal coding was done using NVivo.

Theoretical framework 2.1: Dimensions of a community of practice

Second, the findings produced in the first step were fit into the conceptual framework of the Community of Practice model in order to show how the EPBN developed and functioned as a practice-based community. According to Wenger, McDermott and Snyder (2002), a CoP "is a group of people who interact, learn together, build relationships, and in the process develop a sense of belonging and mutual commitment."

There is a precedent for blog scholars utilizing the CoP model, particularly those in the field of education (Byington, 2011; Freeman, 2012; Hung, 2012; Kang 2011; Mewburn, 2011; Park 2011; Purchase, 2011; Ramble, 2013; Welsley, 2013). Practice-based blog communities have also been examined in the areas of health and medicine (Baker, 2013; Burrell, 2009), information management (Mackey, 2007; Pan, 2011), food (Arsel, 2013), communication (Silva, 2009; Toledo, 2009; Cleary, 2012), and entertainment (Waldon, 2013). These studies have demonstrated that the CoP is a useful framework for understanding how online communities emerge, and how community members create normative practices.

Science blogs in particular have been described as spaces that facilitate online community for those with science expertise or science interests (Kouper, 2010; Trench, 2012). Science blogs have also been described as spaces of engagement, via the two-way discourse that occurs through commenting (Amsen, 2007; Bonetta, 2007; Putnam, 2011; Wilkins, 2009). In addition, science blogs have been described a spaces that serve particular goals or functions, such as to disseminate science news (Brumfiel, 2008; Brumfiel, 2009; Colson, 2011; Walejko and Ksiazek, 2011), educate (Amsen, 2007), or popularize science (Batts, 2008; Wolinsky, 2011).

Wenger (1998) defined a CoP as having three distinct characteristics:

- *Mutual engagement:* Over time, participants develop relationships and create social norms that bind them together as community

- *Joint enterprise:* Through their relationships, the participants develop a shared understanding of what unites them and they negotiate a shared mission or focus to a collective domain

- *Shared repertoire**:*** To engage in practice, the community members develop a set of communal resources that are utilized in pursuit of the joint enterprise

This analytical method was selected for the present study because both of the involved theoretical frameworks have been used to examine topical, community-oriented, online communication environments, similar to the EPBN. The first framework was developed by Baym (1998) to online community emergence and dynamics. The second was developed by Wenger (1999) is an established framework across several social science fields that has been used reliable in online community research to measure both social and professional practices (Jeofferson, 2005).

Dennen (2006) paired to two frameworks in her initial Blogadame study to provide more rigor to her analysis; essentially, the measures of Baym's framework are interpreted as subdimensions of Wenger's: The preexisting conditions *temporal structure* and *participant demographics* and the social dynamics *identity, relationships* and *behavioral norms* were used to understand the broader measure *mutual engagement*; the preexisting conditions *external context* and *group purposes* were used to understand the broader measure *joint enterprise*; and the preexisting condition *system infrastructure* and the social dynamic *forms of expression* were used to understand the broader measure *shared repertoire*.

A similar analytical scheme was used for this study. The frameworks are useful for examining the EPBN and addressing the research questions because they each serve to uncover key elements of social and professional practice. Specifically, they reveal the following about this the EPBN: (1) Who is involved with the Network, (2) The ways in which its participants interact with each other (3) They ways in which its participants access and communicate information (4) The technological and cultural conditions that shape the Network and (5) the behavioral norms that shape its participants' communication and interactions.

CHAPTER 4: RESULTS

Preexisting structures

External context

The data showed that two central features of external context: The general online environment surrounding the EPBN and the driving forces behind the blog community.

In this situation, the driving forces that led to the formation of the EPBN were closely related to the network's general online environment. The PLOS organization was launched in 2000 as part of the open access (OA) science movement, which strives to make scholarly research accessible to everyone. PLOS was initiated by a team of prominent researchers, led by Harold Varmus, a Nobel Prize winning physician and the former Director of the National Institutes of Health. In 2003, PLOS began publishing its first journal, *PLOS Biology*. It currently publishes seven journals, all peer reviewed, that feature scientific, health, and medical research. Through those publications, PLOS has earned a reputation as an effective and sustainable enterprise, and is widely considered to be a leader in the OA movement.

In the decade since it launched, PLOS, like many other academic publishers, has grown its online presence and sought ways to remain relevant within the shifting media landscape. In 2006, PLOS expanded its brand to the blogosphere. The organization witnessed the increased utilization of blogs in science communication and recognized that the informal communication style utilized by science bloggers was effective in attracting the attention of readers and explaining scientific ideas to the lay public. It saw potential in the blog platform to better engage

both the formal scientific community and the lay public in discussions concerning science, medicine, and health.

PLOS's transition into the blogosphere coincided with 'Pepsigate' and the implosion of Science Blogs. PLOS benefited from ScienceBlogs's downfall in two ways. First, PLOS had an opportunity to seek established bloggers from the ScienceBlogs exodus who were seeking a new direction and a new network to call home. Second, PLOS recognized from the inception of the blog network that there are inherent ideological tensions its blogs being affiliated with it as a media organization, and so it took structural and managerial precautions against tainting the "independence" of its recruited bloggers. The organization separated the blog network into two branches—their institutional blogs, i.e., their "staff" blogs, which are authored by the editorial staff members of PLOS's journals; and their "independent" blog network the EPBN, which is run by unpaid researchers and writers who write without editorial oversight.

When interviewees were asked about the general tone and feel of the PLOS environment, common responses were that the community felt "open," "free," and "laid back." All of the interviewees said that they considered themselves to be independent bloggers, despite the fact that their blogs are linked to PLOS. In addition, they all stated that they felt that they were able to publish as frequently or infrequently as they chose, to write about any topic of their choice, and they could express their opinions freely. Travis Saunders, an obesity researcher who co-authors the Network's most trafficked blog, Obesity Panacea, said of his experience with PLOS:

> "Yeah, we're pretty much free. I mean, we have some sort of blogging guidelines that basically say's that we're responsible for what we post, and that we won't say anything ridiculously offensive. We're allowed to post what we want, but we are responsible for

> what we post. If something comes out and it's libelous, then we have to take care of it. They have the right to take down posts that they feel is inappropriate, but I don't think they've ever done that. I don't think that' something that's ever happened."

Because of this, the interviewees were generally enthusiastic about blogging for PLOS. Ricki Lewis, a geneticist who authors DNA Science Blog, summarized her experience with the EPBN by stating:

> "I love the ability to be my own boss. I really look forward to blogging. It's fun and it gets me… No one has to approve my ideas. It's wonderfully freeing to be able to find something weird and just write about it."

Most of the PLOS bloggers were blogging on their own websites prior to joining the network. Each was recruited into the EPBN by invitation, based on their reputations as prolific researchers, writers, educators, or a combination of all of the above. The interviewees spoke at length about their motivations for blogging and also their motivations for joining the EPBN. The most frequently mentioned motivation for blogging was a desire for a recreational activity outside of their professional duties and responsibilities, and blogging was often referred to as a "hobby." Martin Fenner, who authors the technology-focused blog Gobbledygook said:

> "…I wasn't interest in talking about my sort of 'day job' and the experiences I had there, I wanted to keep them [work and blogging] separate and I tried to stay focused on science communication on the more general level, this is what happened to me today and this is how this should work. They were separate, and I guess you could say that one motivation for me was to do something that was not related to work. Some people have hobbies, like music and playing sport, and I guess I just wanted to do some writing that was not work-related."

Another reason given by the interviewees was a desire to introduce alternative perspectives and narratives related to their respective field into the scientific discourse. Lewis, in particular, felt strongly about using the blog platform to bring "something new" to writing and about her field of expertise. She said:

> "I always strive to find ideas that no one else has thought about and to make connections that no one else has thought about, and I think I can do that because I'm a scientists first and a journalist second . I've been writing textbooks for almost 30 years, and with that kind of background I can make connections that other don't…I wanted to add to the perspective and the history that I feel is lacking in the blogs that just parrot what comes out in the news releases."

Andrew Farke, one of three blogger that authors the "ECO" blog Integrative Paleontologists, said that he started his blog to give a platform to colleagues that he felt were marginalized in his field. He said:

> "I don't know how much you know about paleontologists….but it's a lot of white guys. A lot of old white guys. We sort of run everything. So, yeah, I wanted to get into blogging to give myself another platform to speak, but I also purposefully found women to work with…I really wanted this blog to have some female voices. There aren't a lot in our field, but they're here, and the two I'm writing with are top-notch scientists who contribute a lot to this blog."

Several of the bloggers said that they started blogging out of a frustration with institutional norms, in particular academic publishing practices, and they started blogging as a way to challenge those practices. Greg Downey, an anthropologist that authors the blog

Neuroanthropology, gave a passionate explanation for why he blogs:

"…With the anthro journals, I don't know if you know, but the publishing turnaround is just ridiculous—I mean, you're lucky if an article comes out in a year. It's more likely to be two years or more between the whole process. It's just so slow, and I'm not a patient person… for me, blogging is part of a strategy of refashioning myself, repositioning myself, outside of the field. To me, to write a journal article that gets cited six times—What's the point? What is the fucking point? I feel like too much of what anthropologists do is just locked up in secure journals. It's just too fascinating—and nobody's going to read it… there is a lot of disruptive stuff that we can do, as long as they don't have us by the balls because of this whole promotion/refereed journal thing. To me, the refereed journal thing—it's fear of this institution to be so powerful.. .now [with blogging] I can do some really exciting shit. …I really see blogging as the future of the public face of our field."

Another reason given was the desire to engage with diverse audiences. Seth Mookin, a science writer that authors the blog The Panic Virus, started blogging to sustain conversations surrounding his work. He also saw an opportunity to reach broader audiences. He said:

"…It was a good way to communicate directly with a very engaged audience. The traditional lead time for a book [to be published] is anywhere from six months to a year, so by the time my book came out in January 2011, there were a lot of new and interesting things that had come out surrounding vaccines that I had been thinking about and writing and researching these topics for years, and I wanted to continue to engage with them, and I found that it was a way to both force myself to continue to think about things critically

> and also to reach a different type of audience…..one that might come across my book naturally, just continue to engage with them."

Despite their frustrations, the interviewees admitted that institutional affiliations are necessary to gain visibility and legitimacy as bloggers, which is why many of them joined the EPBN. Saunders said:

> "Legitimacy is a big thing, especially among academics. You don't want to be just some random blogger. Some of the more traditional researcher would say 'Oh, he's just some guy on a website, whereas if you're blogging with PLOS, which is a pretty well-respected journal, it gives you some legitimacy. And other little benefits, like Google News, whereas if you're an individual blogger you don't get any exposure…So, yeah, generally it fits with what we wanted to do with science communication, but there were benefits too."

Several of the interviewees acknowledged that, in a post-Pespigate blogosphere, joining a network that is associated with a media group, even one affiliated with the progressive OA movement, was still somewhat risky. A few of the interviewees even referred to their affiliation with PLOS as "controversial," and spoke of legitimacy and credibility within the context of traditional journalism. Lewis stated:

> "…There are so many bloggers that it's not special anymore. I don't want to get lumped in with bloggers that make mistakes all of the time. So, I know I sound like a snob, but I've been a science journalist for thirty years, and back in the day you had to be good to get an assignment, but anyone can write a blog now."

Most of the interviewees felt that joining the EPBN legitimized them to the public and science journalists by making them appear more competent and responsible as newsmakers and

storytellers. Still, the tradeoff seemed to be creating a void between themselves and the other science bloggers who remained out of a network. Fenner spoke of this issue and why he felt that his move to the EPBN was valid:

> "I think there's the fear that there will be sort of second-class and first-class bloggers, just by the visibility you get by the blogging network and the support you get from that, but I don't really think it's worked that way. It's really more about individual bloggers and finding them. And every year it's getting easier to set up a blog, so the technical challenges of doing that don't really matter anymore. So, I think if you want to get visibility as a blogger, a blogging network might sometimes be helpful, but for others it is more about building your own personality on the web, if you will. And maybe there's ways other than a blogging network to be 'successful', if it's using social media, going to conferences, or I don't know, but there are other ways to do it."

In addition to seeking legitimacy, all of the bloggers said (directly or indirectly) that they joined the EPBN because they support the OA movement. Overall, they believed in the PLOS mission and the organization's guiding principles. In particular, several interviewees said that they felt PLOS was fulfilling a need in the formal scientific community by opening a dialogue with the general public. Seth Mnookin, author of the "CULTURE" blog The Panic Virus, said:

> "….Open access is something I support, and in the academic science community, in the extent to which the public has access to scientific research, PLOS has allowed me to support that… I think that some of them think that what PLOS and The EPBN stand for is a sort of free-wheeling intellectual exploration."

System infrastructure

The EPBN uses Wordpress as a publishing platform. Three primary features of this platform—user-friendliness, flexibility, and compatibility—help to sustain the online community.

Like most popular blog software, Wordpress is widely considered to be user-friendly. Overall, the interviewees said that they encountered very few problems utilizing the platform. Most of them had prior experience with Wordpress before they joined the network or they had used a similar publishing platform (like Blogger). This provided them with the necessary knowledge and skills to make the successful transition to Wordpress.

Wordpress provides users with considerable flexibility with respect to blog content and style. Users can publish posts with multimodal content, which allows for potentially diverse and complex forms of expression (Wordpress only allows users to publish text in the comments). The three most common types of media identified in the sample of the EPBN posts were text, images (e.g. photos, graphs, table, etc.), and video. In most instances the images and videos were supplemental to text, and were provided for the sake of clarifying an idea or concept.

This mixed media approach was best exemplified by climatologist Tasmin Edwards on her "ECO" blog, All Models are wrong. Edwards joined the EPBN Network in January 2013 and made her first four posts as an "introductory series" that focused on the foundational principles of climate modeling: In the January 14 post "We Have Nothing To Fear" she defined the term "model" and attempts to explain the level of expectations that should be attached to climate modeling; In the February 1 post "Virtually Reality" she contextualized the term "experiment" with the context of climate modeling; In the April 8 post "Tuning to the Climate

Signal" she delved into the origins of her blog's name to teach her readers about statistician, George Box, (who had recently passed away), and the concept of parameterization; In her May 9 post "Possible Futures" she pondered 'What would…if…?' scenarios to illustrate the importance of conditional probability in her work. Within each post, Edwards intersected text with tables, maps, and video simulations to clarify and further illustrate her points. In addition, she hyperlinked important terms, names, and research studies to connect her readers to source materials. By doing this, Edwards utilized the capabilities of the blog platform to create a rich and engaging narrative experience for her readers.

In addition, Wordpress allows for the expansion of website functionality by making the platform compatible with most software plug-ins. In addition to comment features, every blog in the EPBN has some combination of social media plugins, the most common being Facebook and Twitter. This allows users to share content beyond the boundary of the blog itself. John Rennie, author of the "CULTURE" blog The Gleaming Retort, said in his interview:

> "…People often have discussions about what's the best way to handle comments or engagement with social media these days….and that's another interesting way in which the conversations about these things doesn't necessarily play itself out within the articles. If you really want to know how certain things are going over, you don't just look at the comment section, you also look at what's happening with the article in terms of mentions on Facebook, or how widely it is being tweeted or shared on Google+, or whatever else."

Several of the interviewees said that social media plugins are "necessary" to facilitate blog discourse. Twitter, in particular, was frequently mentioned as a space that gives increased visibility to posts and a longer "shelf life" to discussions related to the posts. Fenner said:

> "I think there is less commenting than there was a few years ago. Just because of Twitter, and to lesser extent Google+. A lot of the stuff that you see on Twitter (happened—delete) use to happen in comments. Now if you read something you react to it by writing a tweet rather a comment… Interesting stuff I see on Twitter or Flipboard…if there's an interesting blog posts, I probably see it on Twitter, especially if it's retweeted by many people. And I think that's the thing—comments taking place in not a single place –how do you find a discussion about blog post?"

The analysis of the blog content showed the technological capabilities of commenting within the EPBN. Commenting is one of the default features of Wordpress; the platform allows bloggers (or blog managers) to control some of the relevant settings. Commenters have the option of registering with Wordpress and creating a profile that includes a photo, username, and any other personal information they would like to include. However, users don't have to create an account to participate in the community and can post anonymously. Several interviewees said that they believed that the ability to comment anonymously made it "easier" and "more comfortable" for readers to engage in blog discussion, especially when posts focused on controversial topics.

Temporal structure

There was no "regular" rate of posting on the EPBN although, in the sample, the average number of posts per blog per month was two. Given the lack of oversight by PLOS, bloggers can produce content based on personal desire. Almost every interviewee said that they posted enough to keep their blogs "active," although there was a wide range of ideas of concerning what that term meant.

Participants in the EPBN community have the ability to communicate with each other asynchronously, due to the commenting feature and social media plugins. The temporal structure provides the opportunity to follow or participate in discussions at any time. This can be beneficial, given the complexities of some of the subjects' discussions on the blogs. The ability to leave and return to discussions gives participants the time to reflect on already present ideas and respond with ideas that are informed and well-constructed. In line with this feature, some of the interviewees said that they hoped that their respective comments sections as "constructive" and "purposeful."

An example of this constructive comment discourse occurred on the "CULTURE" blog Sci Ed. One of Sci Ed's five bloggers, Christina Russo, contributed a piece on March 13 titled, "Can you worry about an animal that you've never seen? The role of zoos in conservation education," where her main argument was that zoos help people form affective connections with animals that are beneficial for conservation. Giving credence to Russo's statement, "Zoo critics will always exist," some of the comment threads were heated debates between supporters and dissenters of keeping animals in captivity.

One conversation between readers "Moos" and "Lori Marino" demonstrated a well-paced and thoughtful dialogue. Over the course of three days (March 17-19) Moos, who agreed with Russo that zoos can serve as educational spaces, and Lori, who felt that zoos lack any educational purpose, respectfully exchanged ideas about their personal convictions. Although neither revealed their respective professions or levels of expertise, each supported their ideas with links to scholarly evidence, and each attempted to refute the other's claim using only source information and logical appeal, without ever resorting to derogatory remarks. They did not ultimately reach an agreement; however, each acknowledged that the other presented a fair

argument (See Appendix B for transcript of conversation.).

Group purposes

Two organizational missions guide this community: the one of PLOS and the one of the EPBN. PLOS states that its mission is "to accelerate progress in science and medicine by leading a transformation in research communication." In addition, PLOS has nine core principles that more concretely explain what their hope to accomplish as an OA initiative (paraphrased, as follows): (1) to advance the OA movement, (2) to set a standard of excellence in publishing and education, (3) to maintain scientific integrity, (4) to provide a breadth of research, (5) to provide a structure for a cooperative work environment, (6) to be a financially fair business operation, (7) to facilitate community engagement, (8) to support community engagement that traverses international barriers, and (9) to develop and support other tools in the OA movement aimed at making science a public resource.

The mission of the EPBN is a more narrow extension of the PLOS's organizational mission, and it emphasizes the Network's desire to be an accessible and diverse online community. The EPBN's main website states that the shared mission of the community is to "promote greater understanding of breakthrough science for a variety of reader types, including policy makers, the academic science community, researchers, medical and mental health practitioners, journalists and the general public."

In addition, each blog within the network has an "About" section that briefly discusses the purpose of the blog and provides biographical information about the blogger(s). Overall, the "About" sections have framed the blogs in three ways: (1) As news information sources, (2) as

educational tools, and (3) as online think tanks. The "ECO" blog The Integrative Paleontologist is an example that fits into this news framework. Its bloggers, field researchers Andy Farke, Shaena Montanari and Sarah Werning, wrote in their blog's description, "Our blog covers the latest paleontological research, with special attention to issues concerning open science, publishing, and fossils in the digital realm." The "CULTURE" blog Citizen Sci is an example that fit the education framework. It's described as a collaborative learning space that focused on "cooperation between professionals and citizen scientists to co-create scientific knowledge" to "help chart the changing landscape of public participation in scientific research." Finally, the "HEALTH" blog, Translational Global Health, fist the think tank framework, and is presented as a space to share, discuss, and distill scientific information. Lead blogger (one of six) medical doctor Alessandro Demaio, wrote that the blog "facilitates the translation of findings from basic science to practical applications in global health practice, and thus creates meaningful health outcomes for diverse populations and societies."

The interviewees were able to provide further insights into group purposes by discussing the goals they had for their respective blogs. The most commonly mentioned goals were to (1) popularize and legitimize their particular research field or area of interest, (2) demystify science to those outside of the scientific community, and (3) make social connections between those inside and outside of the scientific community. Popularizing and legitimizing science were common goals of the interviewed scientists, more so than the journalists. For example, Downey, an anthropologist, focused his research within neuroanthropology, an emerging sub-field that bridges anthropology and the brain sciences. While his work has been celebrated by the neuroscience community, he has had difficulty gaining respect with more conventional anthropologists. He uses his blog as an opportunity to give people an understanding and

appreciation for what he does. He said:

> "I mean, the word 'popularize' is often used as an insult, but I see that as an important role and I see myself as potentially doing that well….I'm a pretty good lecturer, I'm a pretty good storyteller, and I do interesting stuff that people actually like. You know, like, sports. It's a great thing to talk about cultural differences because lots of people care about sports. So I see myself as using the blog to practice actually writing popular genres, because we aren't rewarded for that in academic writing and I can definitely see how my writing is getting better for that audience because of the blog, and it's changing the way that I write and I like it…"

On the topic of legitimization, he spoke of how his work resonates with younger researchers in his field:

> "…But I also think there is a new generation of anthropologists coming along, younger than myself, who aren't really interest in the old, you know, 'it's culture vs. biology', what is argued. Instead, they're more interested in bridging, thinking 'you can't divide up a system like that, you know, even before you're born you're being shaped by your environment and it's part of your biology.' So, I see myself as totally an anthropologist, and what's truly surprising to me is the degree to which I reach an audience outside of anthropology."

Demystifying science was a common goal for interviewees who studied and wrote about scientific areas that were potentially confusing or frightening. For example, Angrist, a geneticist, said:

> "My fondest hope is that they [the lay audiences] would learn something about

> genetics and that it wasn't scary and that it doesn't have to be restricted to people with white coats and advanced degrees…that it would demystify it."

In line with the broader mission of PLOS, interviewees identified connecting the formal science community to the lay public as a goal. Most of the interviewees acknowledged how these connections were informal; however, Lewis said that her DNA Science blog allowed her to create meaningful (and sometimes real-life) connections between her readers. As a researcher and a genetic counselor, she frequently works with people seeking genetic advice and treatment. She uses her blog to help people outside of the scientific community gain access to the resources and expertise that they need. She said:

> "So, that's what I use this [the blog] for, and I've done it a number of times, because the patients don't know the medical system well, and it can take years to get a diagnosis, so a lot of times, and I do this for people all over the world, I will directly connect patients to researchers. And it directly benefits everyone, because researchers want people for clinical trials…so that's what I like to use the social media for, not just for promoting myself, but for helping people make connections, families and researchers."

Overall, there is a strong thematic thread through the intended group purposes established by PLOS and the EPBN. At each level of the blog community, goals were formally or informally established within the context of the OA movement.

Participant characteristics

The "About" sections of each blog in the Network reveal demographic information about the bloggers. There are a fairly equal amount of male (52%) and female (48%) bloggers in the

EPBN Network. The majority of the networks bloggers (91%) reside in North America. The remainder resided in the UK and Australia.

More than half of the bloggers are research scientists (64%); of this group, there is an almost even split between individuals with PhDs (54%) and graduate students (48%). The remaining bloggers consist of science writers (20%), practicing health professionals (8%) and those involved with science education and science policy (6%).

Outside of PLOS, almost all of the bloggers are well-known within in their respective fields and are affiliated with prominent academic, scientific, and media institutions. For example, John Rennie is the former editor of *Scientific American*; James Coyne, lead author of the psychology blog Mind the Brain one of the most cited clinical psychiatrist in the world; Obesity Panacea authors, Travis Saunders and Peter Janiszewski, have established reputations in the Canadian medical and health community due to their successful academic extension work related to childhood obesity.

Also, in the spirit of the PLOS mission, approximately half of the bloggers have ties to other progressive scientific organizations, programs and initiatives. For example, Misha Angrist is a Duke University research scientist who made international news in 2006 when he became the fourth member of the Personal Genome Project (PGP), and gave permission for his personal genome to be published online. The blog CitizenSci is anchored by a team of scientists and journalists that are also manage the crowd funding website SciStarter, which has been described as "Kickstarter for citizen science."

It was difficult to gain demographic information pertaining to commenters as readers do not have to register with Wordpress to comment on a PLOS blog. To comment, an individual

must only create a username and provide a valid email address. However, there were implicit indicators in almost every sampled comment, and explicit indicators in some comments, that gave insights into the professional characteristics of the EPBN readers. From these clues, it was determined that commenters fall into two categories: science experts and lay experts.

Science experts were typically research scientists or practitioners in the field relevant to the blogs' subject matter. These individuals tended to identify themselves explicitly with their names, professional affiliations, geographic location, and/or area of expertise. For example, on June 16, on the climatology blog All Models are Wrong, commenter "Ben Harding" participated in a comment thread in response to, "Debrief from Cheltenham, a post that discussed modeling secondary solar effects. He began his fist comment, in response to a question by another comment Richard Booth, with the following:

> "I'm a civil engineer in the U.S. who provides services in the area of water resources planning. If, when and how to adapt to climate change is a big concern of many of my clients who manage water supply systems in the arid American southwest. I read this blog for some insight and, frankly, sometimes for entertainment…."

Lay experts were typically individuals outside of the scientific community who had considerable knowledge concerning the relevant subject due to personal interest or independent secondary research. For example, on February 26, commenter, Cade DeBois, commented on "Evolved Fists or the Best Weapons at Hand?" that explored how evolution had reshaped the human hand and produced the "unintended" consequence of giving today's humans' stronger fists. Cades comment was lengthy enough to be a blog post itself— nearly 900 words, and it skillfully challenged author John Rennie's central claim that fighting had played a central role in

the evolutions of human fists. Initially, his comment suggested that he could be an credentialed field expert of some sort:

> "…In the animal world, fighting as a part of the (for-delete) courtship is often done with the intent to intimidate or superficially wound the opponent at the most. It's rarely to the death. The point is to breed, not die. Fighting for protection often requires a different set of skills, as well as a healthy dose of knowing when to flee. Likewise, most predators, although impressively armed, will err on the side of self-preservation—no point in taking down a rhino or a gazelle is you end up wounding yourself in the process. Human aggression is quite different–it's innovative, it's adaptive, it does not solely rely on physiological evolution but also on a different tier of evolution: what we are able to achieve through creativity…."

However, he concluded his comment by identifying himself as a layperson. He said:

> "I'm not scientist, by the way, but I am a musician–guitarist, lutenist, and pianist–and so I know quite a bit about how humans use their hands, not to mention a good deal about hand anatomy, and it helped that my father was PhD of (in) Human Anatomy and I grew up around his textbooks. It will take a lot more than this to convince me we evolved the ability to make a firm fist so as hit each, as opposed to giving our hands more strength and vastly finer dexterity so we could do the many creative and communicative things we humans do." (See Appendix A for full text.)

Both types of commenters demonstrate that the EPBN's readership is largely comprised of individuals who have some degree of scientific literacy. They are interested in the subject matter and comfortable enough with field-specific concepts and terminology to engage in the

discussions that emerge within the comment threads.

When asked who they thought comprised their readership, all of the interviewees said that their felt their audience was comprised of individuals who were "interested" in the subject matter. Roughly half of the interviewees said that they felt their audience was comprised of individuals who were "curious about" or "had questions about" their area of expertise. In addition, roughly half of the interviewees said that, while they hoped to engage with a broad audience, they felt that their readership was restricted to mostly field insiders. Related to this, Fenner said:

> "Well, I don't think I write for a lay audience. I think I write for scientists that are interested in this stuff, but don't know how to do things, and are looking to learn… It's a blog for scientists and people who care about this stuff, which is just a tiny fraction of scientists…even smaller than the blogging audience is the technical blogging audience…it's stuff that's really special, and I guess it's just for people who are interested in the stuff …So, in that sense I feel like I have an audience that is consistent."

Audience "consistency" was mentioned by three other bloggers, who said that they believed that they had a stable readership and recurring commenters. Consistency was noticed in some of the blogs, particularly those that focused on niche research field and subject areas. For example, the blog Neuroanthropology, repeatedly drew comments from a small, reccurring group of individuals, for example commenter "Laurie" commented on every post in that blogs sample and demonstrated an interest and knowledge of the subject matter.

Social dynamics

Forms of expression

People participate in the EPBN community by sharing and discussing science-related research, news, and information. This process is initiated by the bloggers, who publish posts, and it is then carried out by the bloggers and readers who have conversations about the posts though commenting and other forms of social media. The analysis of the posts and comments focused on three central features of expression: style, context, and structure.

The communication style used throughout the network can be described as informal. Posts were typically written in first person and used laymen's language, which gave them a conversational tone. For example, in the January 25, post on the Integrative Paleontologists, "And This Is Why We Should Always Provide Our Data…," author Andre Farke playfully discussed a recently published study about carnivorous tooth identification. He said:

> "…Paleontologists have a love/hate relationship with these teeth. On the one hand, they're cool and pointy and fierce-looking. There's nothing more thrilling than finding a tyrannosaur tooth! On the other hand, teeth kinda stink when it comes to species identification. A dromaeosaurid ("raptor") tooth is a dromaeosaurid tooth, and you'll never be able to get down to species level in most cases. So, museums have drawers and drawers of teeth identified as "Tyrannosauridae", or "Troodontidae", or "Dromaeosauridae." To make matters worse, the delicate skulls and skeletons of many of these carnivores, which are useful for identifying species, are pretty stinkin' rare…." (See Appendix C for full text)

Here, the author used language that mixed scientific jargon and species names with slang

terminology (“cool”) and improper word forms (“kinda” and “stinkin’”). While he speaks as an authority, he purposefully dampened his academic tone, which made him and his content more accessible to his varied readers.

This informal style was seen consistently throughout the blogs’ comments. While the commenters made thoughtful and relevant remarks, their grammar, word choice, and sentence structure were casual. A comment from the aforementioned post exemplifies this:

> “Good points, Andy, and good work. A nit-pick however, regarding the caption of the tooth illustration from Larson and Curie: these are not just eight “tooth types,” they are eight particular, actual teeth. Sooo… though they arose from across a long span of time, they came from eight actual creatures, each of which belongs to its own characteristic species…”

This commenter, “Kevin T. Kieth, is knowledgeable about the subject matter, and respectfully and thoughtfully identifies an error in Farke’s work. Still, the commenter speaks lightly; he refers to Farke by his nickname and uses language that is typically not seen in professional or academic writing (such as “nit-pick” and “Sooo”).

The data from the interviews supported this finding. Across the interviews, the bloggers said that they felt “informal” and “accessible” writing and communication was fundamental to their successful blogging. The overall sentiment was that any science discussed should be presented logically and factually, but at the same time made clear and understandable to everyone. Dave Kroll, who authors the “HEALTH” blog Take as Directed said of his writing style:

“I would say that the style of writing really depends on who I’m trying to reach, so there

> will be some days where I will write about a new peer-reviewed type of an article in a way that I intend for scientists, maybe general scientists. But particularly, as of late, I've been writing for the general public. Um, and I think that my loyalties don't lie anywhere, um, other than the truth…my loyalties really lie to myself and my own personal integrity. I want to feel like I'm providing… that I'm using the knowledge, the training that taxpayers have given to get me to this point, um, to pay back to the community in a way that's accessible and consumable to them."

Perhaps in line with making the information more "accessible" and "consumable," it was a common in the sample for both bloggers and commenters to make references to pop culture in their writing. This was seen across the sample of blogs, but identified most often on the "HEALTH" and "CULTURE" blogs. For example, on DNA Science Blog, author Ricki Lewis frequently made reference in her posts to music, film, and pop culture to make ideas and insights about genetics more tangible. In her January 3 post "Comparing Adam Lanza's DNA to the Forensic DNA Database: A Modest Proposal" she used a major Hollywood film to contextualize a discussion of how genetic signatures can (potentially) identify criminals. She said:

> "Would use of a genetic signature for criminality plunge us into the world of *Minority Report*, the 2002 Tom Cruise film in which police in a dystopian society arrest people before they've committed crimes? I would hope not. But I can imagine a scenario in which a psychiatrist uses such a genetic test for a patient whose background suggests violent tendencies. The patient wouldn't suffer Tom Cruise's fate of premature punishment, but perhaps wouldn't be allowed to purchase a gun." (See Appendix C for full text)

Similarly, in her January 31 post, "Another Bump In The Road for Gene Therapy?" she used a classic young adult novel to contextualize her reaction to a recent study about the genetic disorder, Leber congenital amaurosis type 2 (LCA2). She said:

> "…When I read the paper, I couldn't help but think of the novel, Flowers for Algernon by Daniel Keyes, which inspired the film Charly. A young man with mental retardation (the correct term in 1958, when it was written) is chosen for an experimental treatment that has greatly increased the intelligence of a mouse named Algernon. Told through Charlie's journal entries, the tale traces his restored intelligence, and then it's tragic dissipation. Will the people who've had gene therapy for LCA2 experience Charlie's fate, a temporary gift of normalcy? Nothing suggests this yet, but the new study is disturbing."

The commenters usually mimicked the author and used similar pop culture referenced in their comments that were used in the original post. For example, the comments provided for Lewis January 3 posts frequently made mention of *Minority Report* and Tom Cruise to anchor their discussions.

Also, a trend with the sample was for bloggers to construct their posts as narratives. The bloggers tended to write posts that had strong narrative arcs that followed the classic storytelling format: exposition, rising action, climax, falling action, and resolution. Within this arc, the individuals that are typically involved in the scientific research process, such as scientists and subjects, were presented as characters with background stories, motives, and personalities. This rhetorical strategy worked in a number of contexts: (1) when giving a historical account of an influential scientific finding (Example: The April 25 post, "DNA Day and World Malia Day:

The Sickle Cell/Malaria Link Revisited" from the blog DNA Science Blog), (2) when discussing the method behind a recent research publication (Example: The aforementioned January 25 "And This Is Why We Should Always Provide Our Data…," from the blog Integrative Paleontologists), (3) when discussing a past or current site visit (Example: The February 26 post "Fishing Without a Fossil Part 2" from Integrative Paleontologist), (4) when reporting from a conference or other field event (Example: The February 11 post "Citizen Science Synthesis: Observations from Science Online 2013" from the blog CitizenSci), (5) when discussing a current event or hot topic in relevant to the field (Example: The January 21 post "#overlyhonestmethods – Reaching Out With Humour" from the blog Sci Ed), and (6) when sharing personal or professional reflection relevant to one's respective research field (Example: The March 11 post "The Making of a Cultural Neuroscientist" from the blog Neuroanthropology).

Sometime, these narratives would be completed over a number of posts, as presented by the blogger(s) as a series. The aim of the bloggers seems to be to "hook" the readers with content that not only had enriching content, but also a sub-plot. Also within the sample, roughly more than half of the blogs featured at least one post series and roughly a third featured two. For example, The Integrative Paleontologists had a series of posts (the "Fishing without a Fossil" series) that focused on trace fossils, or fossils left behind by an organism. More narrowly, the posts focused on coprolites (or as the authors comfortably stated, "poo") to illustrate that fossils are more diverse than just bones.

In addition, these narratives tended to have a 'take-home message' for the readers, so they could answer the question, "What's the point?" of the scientific information that was just presented to them. The "HEALTH" blog, Obesity Panacea, was the most obvious in doing this;

several of the posts would end in a section called “What’s the point?” or “What does this mean?”, where the authors would firmly summarize the main ideas of the content (like scientific news, research findings, or field-related anecdotes) that preceded it.

Identity

As previously mentioned, each of the bloggers was invited to join the EPBN based on the strength of his or her respective professional reputation. As such, it was important for bloggers to maintain a professional identity within the Network. Although their blog posts and contributions to comment threads are written in an informal style, the bloggers still use mechanisms to assert themselves as authorities in their field.

One way that bloggers present themselves as experts is to reference their previously published work. For the scientists and health professionals, this typically means referencing their content from scholarly articles, textbooks, dissertations, or conference presentations. For others, like the journalists and educators, this typically means referencing their content magazine and newspaper clips, press releases, or popular science books. For example, in every sampled post from the “HEALTH” blog Work In Progress, journalist Jessica Wapner referenced her upcoming book *The Philadelphia Chromosome*. The book explores a genetic mutation (the Philadelphia chromosome and chronic myeloid leukemia (CML). It also tracks the development of Gleevec, a groundbreaking drug that made this once-fatal cancer treatable with a single daily pill. Wapner’s self-referencing was obviously a means to promote her book (often, when referencing it, she would say “shameless plug” before continuing with her thoughts). In addition, the book served to legitimize her as expert and demonstrated that she was a credible source on the subjects of the Philadelphia chromosome, CML, and Gleevec.

Another way that bloggers attempt to establish themselves as experts is by presenting their posts in an academic format. Within the sample this mechanism was primarily utilized by scientists. Although they tended to write their content in an informal, layman's style, they displayed their content in a manner that would be appropriate for a scholarly research paper. This included providing in-text parenthetical citations and a bibliography at the end of posts. The blog Integrative Paleontologist was the strongest representation of this informal/scholarly pairing. While the bloggers consistently utilized a conversational style and tone in their writing, there was a uniform structure and format across the posts that gave the content a polished and academic visual aesthetic. For example, in the April 1 post "How species are like pornography: species concepts and fossil records," author Sarah Warming made a provocative and humorous argument about the subjectivity the term "species" (that rest on the common "I know it when I see it" logic). Warming's opinion is a fringe one in her field; however, her use of scholarly sources and academic formatting allow her to assert her professional identity, which lent credibility to her thoughts.

Another way that the bloggers present themselves as experts is to let their readers see them "at work." Within the sample, this typically involved the bloggers writing posts about in-progress professional endeavors, e.g. a site visit, research study, or conference presentation. For example, over a series of posts in April, Translation Global Health blogger, Dr. Alesandro Demaio, reviewed and reflected upon the proceedings at the TED MED 2013 Conference in Washington, DC. in which he was both an attendee and a presenter. Dr. Demaio gave his readers daily summaries of conference proceedings and also invited readers to monitor his activities more closely by following him his 'live-reporting' on Twitter. By allowing his audience/readers to see him actively perform as a medical professional at this high-profile event,

Dr. Demaio helped maintain his identity as a respected field expert, which lent more credibility to his blog work.

Bloggers also establish a personal identity through their respective blogs. Within the sample, the bloggers provided candid information about their personal lives and referenced their families, friends, hobbies, cultural interests, political ideologies, and/or religious beliefs. This was common on the blog DNA Science Blog, where author Ricki Lewis frequently used her personal life in the expositions of her blog posts. For example, in the January 24 post "My Cat had AIDS" Lewis fondly recounts the health journey of her rescue cat, Juice, who has the disease. In her post, Lewis presents herself as a mother and animal lover, more than a genetics scholar and practitioner. She said, relating to a time when Juice's health was failing:

> "…Yet Juice never became depressed like the original cattery cats – quite the opposite. He's charmingly sociable. And so "juice" as a verb entered the family lexicon. "You haven't truly been welcomed into the Lewis home until you've been juiced," explains [her eldest daughter] Heather, referring to the phenomenon of Juice detonating at close range, hurling multicolored mucus. He'd famously do this at parties, where he'd plop himself on any available human and settle in until the next eruption."

In fact, Lewis had a number of posts in which she grounded discussions of genetics research in her personal life: (1) The January 10 post "The Crud: Viral or Bacterial" arose from her recent bout with the flu; (2) The March 28 post "Mayonaise Taxonony" began with a musing about Passover [Lewis is Jewish] and the importance of eggs in her culture at that particular time of year; (3) The April 25 post "DNA Day and World Malaria Day: The Sickle Cell/Malaria Link Revisited" centered around Emmanual, a medical student in Liberia with malaria that Lewis and

her family had been financially and emotionally supporting for years. By doing this, Lewis helped advance her personal mission for her blog. She said in her interview:

> "So that's why it's called "Genetics in Context". I bring together strands and strings and stories in ways that I don't see anywhere else. And you know we all get the news updates and alerts, and everyone will clamor to write the news. I don't do that. While everyone else is writing the news, I step back and look at it, wait a while, and put it into context."

Within the sampled comments, it was more difficult to track identity construction due to aforementioned reasons that make it challenging to verify names, personal information, and professional affiliations. However, a trend across the comments was to use some form of personal experience or professional affiliation to lend credibility to ideas and arguments. For example, on the "NEURO" blog Neurotribes, the April 1st post "What I learned from My Autistic Son" drew dozens of comments from parents of autistic children who provided personal anecdotes. In this exchange, their personal identities as parents of those children and years of close experience with the disorder legitimized their comments and lent credibility to the discussion that emerged around their thoughts. Returning to an earlier example, from the blog All Models are Wrong, commenter "Ben Harding" voluntarily reveals that he is a civil engineer and he provides services in the area of water resources planning. Without providing this information, the subsequent information he provided on climate change might have been easily dismissed; however, by presenting part of his professional identity, he positions himself as someone who has the knowledge and expertise to participate in the discussion.

Relationships

Relationships within the EPBN Network are formed and maintained in three ways: through hyperlinking, commenting, and information sharing through social media.

Hyperlinking is a way for bloggers to "physically" their blogs within the Network. This usually occurs between bloggers within the same PLOS network branch, as they are more likely to discuss similar scientific topics and issues. For example, in the sample, "CULTURE" bloggers John Rennie and Seth Mnookin linked to each other's posts when they were simultaneously writing about Jonah Leher's July 2012 resignation from *The New Yorker*. Similarly, bloggers from the "HEALTH" blogs Public Health Perspective and Translational Global Health would hyperlink their category peer in the Network, Obesity Panacea, when discussing issues related to obesity, diabetes, or fitness. This mechanism is a way for bloggers to promote each other's work and stay connected within in the Network. Rennie said, on the topic of hyperlinking:

> "…the commenting and referring to people across blog posts, that really highlights on The EPBN the people that are just excellent science writers …the stuff that I write about…it's great that there are relevant blogs for me to follow in PLOS …I think that was some of attraction of PLOS at the beginning. You have some strong science communicators, on one hand, and you have some strong blogging scientists on the other hand…. It's what holds the network…"

Commenting provides some opportunities for bloggers to build relationships with their readers. The analysis of the comments showed that the blog authors contribute little to the comments thread; within the sample, most bloggers did not join a thread unless a reader

explicitly asked them a question or directly challenged a thought that was in a post. During the interviews, a common statement from the bloggers was that, while they encouraged comments from their readers, they did not make an effort to be active in comment threads. The most cited reason for this lack of participation was time constraints.

In contrast to their lack of commenting, the bloggers use social media to build relationships with their readers. Approximately two-thirds of the interviewees said that they "actively," "regularly" or "frequently" discussed their blog content via social media, particularly via Twitter. While the bloggers felt that their readers had constructive conversations among themselves in their comment sections, they felt the most engaged in their scientific discourse when tweeting. Said Mnookin:

> "I often feel like in terms of engagement or dialogue, that it occur on other platforms—it may happen as a result of my blog, but the conversation happens somewhere else, like on Twitter ….often times the comments section becomes a back and forth where people don't agree with each other and will never agree with each other, talking past each other, as opposed to twitter where there's sort of a free-wheeling discussion…the conversation is going on all the time on Twitter and I can take part in that."

Lily Bui, a blogger on the "CULTURE" blog Citizen Sci, said:

> "Most of our engagement comes from, re-tweets and FB (Facebook) shares. In terms of facilitating engagement, we're as responsive as we can be whenever people comment on posts….But as a blogger, I feel like I have ownership over the topics I blog about and often respond to re-posts in different places online, mainly Twitter and Facebook."

The EPBN's bloggers are also able to nurture their relationships offline. The Science

Online Conference (which was launched in 2007 and now meets annually) was mentioned by all of the interviewees as an opportunity to connect with other bloggers in the Network, colleagues, and other science communicators. Said Downey:

> "…I've had people come up to me at conferences and say, 'Ah, you know, Neuroanthropology has changed what I'm doing in my dissertation' and that means something to me…That's where I want to see my impact. I want to see the field move".

Similarly, conferences were presented as opportunities to turn in-person connections into blog readership. Fenner said in his interview:

> "…You meet a lot of people and it's easy to have good discussions, but also see people that you might be interested in follow [online] and that's of course very helpful for visibility, I mean if you want to build on your blogging career, if you want to call it that. There's a lot of stuff out there—so why should people read yours?"

Overall, the interviewees said that they primarily felt connected to the EPBN community through their social media interactions.

Behavioral norms

The EPBN has a "Community Guidelines" page that provides overarching rules for community participants. The rules are broad, and heavily rely on individuals using common sense. They are: (1) Don't post anything illegal, (2) Please behave yourself, (3) Don't plagiarize (4), If you leave a comment, you'll have to supply a username and a valid email address, and (5) Re-use content based on Creative Commons License provisions (Paraphrased: See Appendix D for full text.).

Beyond that, bloggers have taken it upon themselves to create more specific guidelines for their respective blogs. These guidelines are often created to regulate activity in the comments section. For example, in her first post, "We Have Nothing To Fear," Tasmin Edwards firmly dictated how she wanted comment discourse to proceed:

> "At my old blog we've had interesting discussions between people from across the spectrum of views, and I hope to continue that here. To aid this I have a firm commenting policy:
>
> - be civil; do not accuse; do not describe anyone as a denier (alternatives: sceptic dissenter, contrarian), liar, fraud, or alarmist; do not generalize or make assumptions about others;
> - interpret comments in good faith; give others the benefit of the doubt; liberally sprinkle your comments with good humour, honesty, and, if you like them, cheerful emoticons, to keep the tone friendly and respectful;
> - stay on-topic."

Within the sample, Edwards strictly enforced these guidelines and moderated her comments section. She frequently deleted comments that she felt were violators and would leave notes in the omitted comments place explaining why she did so. For example, after deleting a comment from "Colin Reynolds" on her first post, Edwards left a message saying:

> "Hi Colin - sorry, I snipped your link to a cartoon as I found it too snarky. I want this space to be about improving understanding of the science and uncertainties, in people across the spectrum of views, while treating each other respectfully. Cheers – Tamsin"

Moderation is a practice that was mentioned by each of the interviewees. The interviewees felt that moderation was a way to rid their comment threads of disrespectful and off-topic comments that weakened the quality of the blog discourse. About this, Greg Downey said:

> "I'm not gonna let some idiot spread graffiti on a site that worked very hard to make serious repository of think…. You know, they're, like, defacing your public presence, they're writing hell on your public persona. Why do you let them do it? Delete it! I want them to all know that their work is going into a black hole. If someone is an idiot, I want them to know that they've waster part of their finite life, and it will never see the light of day. And they'll write, 'Why did the moderator delete my last comment?' Delete again. You know, like it should be. We can fucking do this all day. It's one key stroke for me, you know?"

Similarly, Rennie said:

> "As far as the sphere of commenters that you get, and the kinds of comments that you get, it really is your responsibility as a blogger to tend them as you would a garden. If you just leave it alone completely, if you just say 'Yeah, I'm never going back there,' it will become a horrible fettered place with a lot of hateful commentary and where people with a lot of different points of view will be afraid to say it because they feel they will attract a lot of hate."

Underlying this rationale was the idea that moderation was within their rights as bloggers because, as authors of the information, the blog post belongs to them. This concept of individual blog ownership was a recurring theme from all of the interviewees, and the bloggers frequently

referred to their blogs as "mine." Mnookin said:

> "I definitely feel like it's mine…And I know that there are people who have a different engagement with their comments that I do and treat it differently than I do. I feel like if it's appearing under my name, I'm responsible for it, good or bad. So if something is not accurate appears under my name, I can't say 'Oh, it's a community effort.' But I feel the posts as mine, and the comments as belonging to everyone. So I guess I see it as a dichotomy….I think there's a difference in believing community engagement—you know, not censoring the community, keeping the community open, allowing all different sorts of viewpoints---and treating everything that happens on the site as community generated …I think an important part of what I get out of the blog is being in a space that does allow for community and invites community interactions, but that doesn't mean that I feel like my posts are community generated."

More bluntly, Fenner said:

> "…A blog is something you do and people relate to that through a discussion. So, it's your place and you set the rules, and people can like it or not like it. Of course, if you set stupid rules then nobody will come to your place. But I don't think it's equal in that everybody has the same right, and it doesn't really matter if you're a blog author or somebody else."

This feeling of blog ownership is aligned with the interviewees' previous comments about feeling autonomous from the EPBN. Although they acknowledged their affiliation with the organization, they also maintained that they are independent workers that dictate the content and goals of what they feel are personal websites.

Community of practice

Overview

By identifying the structural factors and social dynamics of the EPBN, I was able to characterize the network as a Community of Practice (COP) based on the dimensions of Wenger's COP model: (1) mutual engagement, (2) a joint enterprise, and (3) a shared repertoire of resources.

Mutual engagement

The data relevant to participant characteristics, forms of communication, external context, driving forces, and behavioral norms revealed how mutual engagement takes place within the EPBN.

Participants within the EPBN are knowledgeable about science through formal education, professional experience, personal interest, or some combination of the three. To engage in this community requires individuals to have some degree of science literacy. At the very least, they should be able to comprehend basic science concepts and also understand some field-specific terminologies. In addition, it's useful for individuals to be aware of current scientific events that affect both the formal scientific community and general society.

Community members are comprised of bloggers and commenters, who engage with each other through publishing, discussing and sharing scientific information. Both types of participants have the capacity to conduct each activity. However, compared to commenters, bloggers are able to act with a greater degree of autonomy, latitude and authority.

Publishing is the act of creating visible content for the network's website. Bloggers

accomplish this primarily through their blog posts and commenters accomplish this by leaving comments in responses to those posts. The data collected revealed that both bloggers and commenters are self-motivated to publish.

Within the EPBN, bloggers can serve as commenters, but commenters cannot serve as bloggers. This role restriction is established and maintained by PLOS. Only individuals sanctioned by PLOS as bloggers are authorized to write and publish posts on the website. Commenters cannot 'move up' or change their status, regardless to how long they have been active within the community.

Discussing is participating in community discourse, specifically in the comment sections of blogs. With respect to this activity, bloggers again have more latitude than commenters. Wordpress allows bloggers to moderate comments on their respective blog sites and it is common for bloggers to exercise this right. If commenters publish content that is not in compliance with the PLOS general guidelines or blog-level guidelines, commenters can be verbally reprimanded or have their comments expunged by bloggers.

Sharing occurs when participants distribute blog content through social media. This can facilitate extended discussions relevant to the blog posts' subject matter. Overall, the interviewed bloggers felt that discussions relevant to their blog posts have been shifting away from their comment sections and towards social media websites. This represents a limitation on the power of the bloggers since social media outlets allow anyone to share blog posts with anyone else, anywhere, and at any time they choose. Outside of the EPBN website, the commentary cannot be moderated by bloggers because the discussions are shaped by the social and structural factors of the social media websites.

The activities that occur within the EPBN community—publishing, discussing, and sharing— illustrates that the PLOS organization, bloggers and commenters engage within an established power dynamic. The dynamic represents itself as a hierarchical community structure where, at each level, participants are allowed to engage in communication as permitted by pre-existing rules.

Joint enterprise

The data relevant to participant characteristics, external context, driving forces, group purposes and identity explain how a joint enterprise develops across the EPBN community.

As stated by the EPBN, its official mission is to promote a greater understanding of breakthrough science amongst a diverse group of readers. Its mission statement is narrower in scope than that of the PLOS organization as a whole, which is to transform the current practices of scientific and medical research communication. Through the EPBN, PLOS's tries to extend its reach as a progressive online publishing organization.

By extension, the intended mission for the EPBN is also to advance the OA science movement. Keeping with the OA values, the intent of the EPBN is to help make scientific and medical research accessible and understandable to the masses. Additionally, it's supposed to expand and diversify the scope of individuals who participate in conversations about science, and also to enrich those conversations through promoting a broad perspective of values, ideas, and opinions.

Those ideals are advertised by both PLOS and the EPBN at the organizational level and contribute to their public brandings. However, because each blog is independently authored, other sub-functions have emerged within the Network. At the individual blog level, each blogger

has his/her own mission or statement of purpose, which is outlined in the "About" section. The analysis of those descriptions revealed that the bloggers' goals are for their blogs to serve one (or a combination of) the following roles: as a news information source, an educational tool, or an online think tank. Collectively, those conceptions demonstrate that the collective intent of the bloggers' to facilitate information sharing and discussion.

Although the written descriptions do not explicitly mention OA-specific goals, the information obtained from the interviews suggests that the bloggers' intent is to support the OA movement though their respective blog sites. The interviewed bloggers said that the goal of their blogs is to popularize and demystify science, and also to help make connections between people in the scientific and lay public communities. Those reasons are aligned the overall mission of PLOS in making scientific information more accessible and understandable to the masses.

The EPBN also has two implicit missions that are primarily driven by the motivations of the bloggers. The first mission is to lend credibility and legitimacy to science blogging. PLOS wants to reassure its audience through featuring bloggers that are respected science experts and showcase their fact-based and unbiased expertise, and that its affiliated blogs are accurate and reliable sources of scientific information. Although the Network does employ an editorial team, it does expect its bloggers and commenters to adhere to certain ethical standards, which provides it with a high degree of consistency, reliability, and respectability. This professionalism allows the Network to compete for market share with other major science blog networks, other online media outlets and the traditional mainstream media.

The second implicit mission is to elevate and strengthen the professional profiles of the bloggers. The interviewees revealed that they feel ownership over their respective blogs, and

that they perceived them to be an extension of themselves as professionals. Because of this, they seek to use the platform as a vehicle for self-promotion and self-networking. The blogs provide an opportunity to expand their professional identities in the digital arena, and to build their respective brands as modern science communicators. Much of their motivation behind this is to challenge and reform the professional limitations that they feel while writing for academic and mainstream news publications. During his interview, Greg Downey stated that with respect to the field of anthropology:

> "To me, the key is to understand, I think anthropology has a bad public profile. We just don't have the impact we should…Why aren't anthropologists more in the public? Ad I think it's because we got burned [by academia]. So this [blogging] is a way for us to do it on our own terms. This is a way for us to promote ourselves rather than beg *National Geographic* to feature us in a nice way, or beg some idiot from the *New York Times*, who has the most stereotypical idea of what intellectuals do, to write a story about us. Because, one of the problems to me is that we don't control our own image and blogging is one way to control our own image. It's a way to control your public face—'image' makes it sound too shallow. It's one way to control how the public comes into contact with you. May instead of saying image, one way to say it is 'entry point', the first impression."

Other bloggers interviewed echoed many of the same sentiments of Downey. They see their blogs as personal public relations tools in addition to being public engagement tools for science. They are aware that blogs allowed for frequent and direct contact between themselves and the lay public. If utilized effectively, their respective blogs can serve to add to their professional credentials.

To summarize, the EPBN has multiple joint enterprises. At the core, the network serves to support the PLOS organization and advance the OA movement. Beyond that, it is driven by the bloggers' desire to further legitimize science blogging as a practice and elevate their professional profiles as science communicators. Those shared goals propel the activities that support the engagement in the community.

Shared repertoire

The data relevant to system infrastructure, temporal structure, forms of expression and relationships reveals how a shared repertoire of resources has developed among participants in the EPBN.

The primary shared resource of The EPBN is the blog's website. The website exists as a hub where participants could contribute their ideas and interact with each other. The two interactive features of the website, hyperlinking and commenting, have been essential to the community. Through hyperlinking, bloggers can connect with each other, and bloggers and commenters can connect their ideas to primary source materials. Through commenting, community participants can facilitate dialogue and provide opportunities for information access, knowledge development and relationship building.

Another shared resource is social media. Each blog in the Network is has social media plugins; with this, the bloggers' content can be distributed or disseminated via numerous websites. Twitter is a social media platform that was frequently mentioned during the interviews. A review of the "Share" widgets on the blogs revealed that Twitter tend to outnumber comments within the; for example, on the blog The Panic Virus there were three times as many tweets as comments. Twitter helps the bloggers make more connections to

science-minded individuals within and outside their respective fields of expertise, which makes it an effective professional networking tool.

CHAPTER 5: DISCUSSION

RQ1: How does the practice identified in the EPBN compare to that of journalism?

Because PLOS is an established media organization, the Network's practice operates within an institutional structure similar that constructed by other mainstream science media brands. Specifically, the practice is grounded in professionalism through (implicit and explicit) writing standards, in addition to publishing and behavioral guidelines. These structures serve to strengthen both organizational and individual brand identities.

Within the EPBN, the need for professionalism underlies the participants' actions and interactions. The three most common characteristics of this professionalism are accuracy, transparency, and respectability. Accuracy is emphasized in published content to minimize the spread of misinformation. Within the Network, there is a culture of self-checking and informal peer review among participants, so published content is continuously vetted and errors are exposed quickly. If misinformation is published, it is expected to be corrected immediately by the author—for example, an addendum to a blog post or a republished comment—to preserve the blog community as a space of reliable information. The process is analogous to alerting a newspaper or magazine journalist about an error in his or her work, and that individual takes the appropriate steps to correct the content. As long as a participant within the EPBN identifies his or her mistake and revises his or her material in a timely manner, the he or she can still remain a valued contributor of scientific information within the blog community.

Transparency by participants is used as a mechanism to maintain accuracy in their content. The easiest way for participant to be transparent is to use hyperlinks. It's common for

bloggers to laud their posts with hyperlinks to source materials to legitimize their claims and arguments. Similarly, commenters that provide links to discussion threads are able to facilitate lengthier and more constructive conversations.

Respectability is an earned characteristic this is primarily associated with the EPBN's bloggers, specifically those who take a business-minded approach to participating in the Network. This means acknowledging that, even though PLOs is a non-profit organization, it still has corporate-like structures and goals. To keep the "corporation" operating successfully, it is necessary for "employees" (e.g. the bloggers) to serve the "customers" (e.g. the readers and commenters) efficiently and effectively. This corporation analogy emerged across the interviews. Although the bloggers are unpaid and do not have publishing quotas, every blogger interviewed said or suggested that they "worked for" PLOS. To honor their invitation to blog for PLOS, there was an expressed desire to "show up" regularly and "do a good job." This was to appease the PLOS organization and also serve their readership. The interviewed bloggers acknowledged that their readers were looking for a quality "product" in the information produced within the EPBN community.

The EPBN's concept of professionalism aligns with common journalistic standards of excellence, where accuracy, transparency and respectability are crucial to the success of journalist and media brands. These journalistic strands of practice that run through the EPBN serve as a reference points of quality to community participants. Although the Network promotes itself as a space of informal inquiry and dialogue, it still serves as a constructive space of learning and discourse, and professionalism applied as a means to evaluate which participants are contributing useful ideas and information.

Professionalism within the community is implicitly enforced through social cues and pressures, but participants' actions are also policed in accordance with explicit community and blog-level guidelines. At the organizational level (e.g. the community guidelines established by PLOS and the EPBN), participants are alerted to the fact that the EXPN is a space of free, but respectful discourse. Contributions from participants should be relative and informative, with proper attributions as needed. The community-level guidelines are more strictly defined at the individual blog level, through blogger-dictated guidelines, and enforced through blogger moderation. Tasmin Edwards's respective blog community is the strongest example of this. In addition to narrowly defined blog guideline for All Model are Wrong, Edwards also vets her comment threads and moderates comments that do not meet her criteria of being relevant and respectful.

Professionalism allows the EPBN, and by extension PLOS, to maintain a positive brand identity and stand as a peer against other prominent science media brands. It is necessary that the EPBN meets performance and image standards that are equivalent to that of other PLOS initiatives. A successful blog network helps the PLOS organization demonstrate that it can support science communication across diverse media channels.

At the individual level, professionalism helps the bloggers gain legitimacy as producers of scientific information and commentators as scientific news. This allows the Network to represent its bloggers' as having aptitudes, similar to those of 'traditional' journalists. A constructive blog community reflects positively on the bloggers' abilities to stimulate and facilitate discourse.

By mimicking the professionalism of 'traditional' science journalism, the participants

reinforce in the Network some of the distinct characteristics of classical science communication. First, the roles of science experts, translators and lay public members seem to be maintained in the blog community. Bloggers serve in the roles of experts and translators interchangeably, and it is their expertise and communications skills that initially draw audiences to the Network. Further, because of their ties to academic and mainstream media institutions, the bloggers have greater access to primary scientific information than the commenters in the community. This allows them to maintain their "gatekeeper" status within the scientific community. Beyond that, bloggers get to decide which elements of their source materials they want to make the subject of their blogs posts, which prompts the tone and talking points of the commenters discourse that follows. The authority possessed by the bloggers places them in positions to be more visible, vocal and directive than the readers and commenters within the Network.

By unequally distributing power within the EPBN and restricting the most autonomy to a small group of known experts, PLOS has made it easier to maintain professionalism within its blog community. The interviewed bloggers frequently described their blogs as "mine" and they populate them with the parts of the expertise that they choose. The structure and practice of the EPBN exists in such ways to support their perceptions of their power. Within the Network, a blogger is a researcher, writer, publisher, teacher and discussion moderator, among other things. In addition, bloggers can control the actions of commenters that comprise their readership. This helps maintain the prestige of their scientific expertise and their privilege to blog within the EPBN.

RQ2: How does the practice identified in the EPBN compare to that of academic extension?

More than half of the bloggers within the EPBN (64%) are scientists affiliated with academic research institutions. Their interactions with their audience members can be considered a type of academic extension. Specifically, the bloggers share translational research with invested audiences for the purpose of making practical impacts on them.

The bloggers communicate scientific research and news to their audience by utilizing accessible topics, language and style language. This is in anticipation of conversing with individuals outside the formal scientific community who may be unfamiliar with the bloggers' respective fields. In addition, they seek to make their fields relevant to those audiences by selecting topics and issues that have that have broad applications in their daily lives.

When possible, the bloggers invite their audiences into the formal scientific community through commentary about major field event like site visits, conferences and talks. This 'glass door' approach to the scientific community is a trait of Science 2.0 culture. As a consequence of their blogging, the scientists are promoting transparency and candor in their own work and the work of their colleagues. They are also helping to further demystify science by allowing their audiences access to it 'in process' as opposed to solely at the end.

The bloggers' approach seems to be appropriate for their readers and commenters who are lay citizens. However, they may be overexerting themselves in the efforts to make their work tangible to the masses. Analysis of the comments showed that most of the commenters are science-minded individuals, who have informally educated themselves due to personal need or interest. These individuals could be classified as cognitive misers, or lay citizens who are inclined to science scientific information or are already scientifically involved in their

communities in some way (Nisbet and Scheufele, 2008). From the analysis, it is still unknown to what extent the EPBN is recruiting into the community lay citizens with no prior knowledge or interest in science.

Still, placing translational research at the center of their communication efforts creates the potential for bloggers to bridge themselves and their respective institutions to broad audiences. The blog posts are an opportunity for bloggers to demonstrate to their readers aspects of science that have implications to general society. Similarly, the comments are an opportunity for non-blogging community participants to make inquiries or test ideas that may enrich their own scientific knowledge and appreciation.

RQ3: How does the practice identified in the EPBN compare to that of blogging?

The EPBN is populated with content that is publically available, informally written and narratively structured in first person perspective. Those characteristic align the Network with the leading conception of blogs, which is that of open, online diaries.

The diary likeness is especially present in the blog posts, where the bloggers use their respective sites to speak directly and personally to the reader. The reader's comments also contribute personality and intimacy to the community. Though the commenters don't usually provide their names, they feel comfortable with telling stories about their life and providing information (occasionally that which is identifying) about their personal and professional lives.

In addition, the technical and social structures of the EPBN support the conversations of the participants, and this characteristic of the Network aligns with the idea that blogs are interactive and dialogic spaces. With respect to science, relevant literature has presented

commenting as the primary mechanism for discourse about science. However, the analysis shows that this is more frequently accomplished in the Network through social media.

Twitter, in particular, seems to be most popular tool for participants to discuss and share information that has been published on the EPBN website. This was made apparent through the interviews, in which the bloggers all acknowledged that Twitter was an integral part of their blogging. The three-to-one ratio of tweets and comments further demonstrated that participants strongly rely on Twitter as a form for communication and networking. What could not be determined, due to personal Twitter personal privacy settings, was to what extent participants tweet to communicate with each other or with people outside of the Network. External tweeting among participants (e.g. a reader tweeting at a bloggers to ask a question relevant to his or her post) would suggest the Twitter is a means for expanding the bounds of the blog community and its discourse.

Within the available sample of comments, there was evidence that the EPBN supports constructive discourse. 'Constructive discourse' was not a term that was concretely defined within this study, and it should be acknowledged that it has a wide range of meanings across communication and education literature. However, the term was broadly defined after data analysis as discourse that was relevant, informative and purposeful. Specifically, discourse though comment threads within the Network seems to hold potential for participants, especially those at odds on an issue, to deliberate and negotiate their ideas. This characteristic aligns with idea that blogs are collaborative and constructive spaces.

RQ4: How does the EPBN function as a space of hybrid practice?

In previous literature, the following cultural shifts in science communication have been discussed: (1) Science journalism is becoming more decentralized and digitalized; (2) Academic extension is becoming more individualized and digitalized; and (3) Science blogging is becoming for centralized and professionalized. For this study it was assumed that the EPBN's practice was influenced by all three subcultures. The Network's hybrid practice was conceptualized as a digital endeavor that was centralized and decentralized, formal and informal, 'traditional' and 'modern.'

This conception of the EPBN was supported by the data. Comingling strands of practice from journalism, academic extension and science blogging contribute to the practice of the Network. It conducted is in a professional capacity but also relies on the personalities of its participants to foster community. It serves promote primary academic research and hard science news to a broad range of science-minded individuals through accessible means. This practice is centralized in an online space, but has the potential to fray due to social media connectivity.

With respect to the cultural practice of science journalism, the EPBN's borrows an institutional structure that upholds professionalism. The Network adheres to standards in order to ensure that publishing and social activities reflect the PLOS as reputable science media brand. The standards emphasize much of what is necessary for successful mainstream newspaper or magazine reporting—accuracy, clarity, transparency, and credibility. Infusing these qualities of science journalism in to science blogging signals to readers that PLOS is subjecting the Network to a level of rigor. This helps readers accept the Network as a reputable for of science communication.

The EPBN also borrows from science journalism its hierarchal structure of influence. The Network represents a slightly modified version of the deficit model of science communication. Information primarily moves 'downstream' between participants, from scientists and journalists to the readers. Commenting between bloggers and readers is a potential challenge to the deficit model, but the data suggest that comment interactions are primarily limited to readers. The moderation of the bloggers further suggests that there are restraints to the extent that readers can influence the Network's discourse.

With respect to the cultural practice of academic extension, the EPBN's practice shares its guiding principles and long-term goals. Officially, the Network serves to be an informative and engaging space that is accessible to the masses. In addition, bloggers within the Network have made individualized efforts to promote relationship building with and among their readers. Those efforts are in the spirit of cooperative extension services that promote translational research and community involvement by scientists. Within the EPBN, extension implicitly occurs, since the scientists tangentially represent their research institutions. The blogs serve to promote the scientists and their affiliated research institutions, while also giving members of relevant publics streamlined access to their work and insights.

With respect to the cultural practice of blogging, the EPBN's practice borrows its technological structure in the blog platform. This structure centralizes the Network's practice and offers the potential for rich interactivity through blog-specific features like multimodality, commenting and social media connectivity. The PLOS web space that houses the blogs places physical and conceptual bounds around the EPBN's participants. The physical interconnectedness of the blogs through the PLOS website allows participants to easily interact with each other and exchange ideas. Conceptually, the centrality of the blogs also bounds the

nature of the participants' interactions. Because of the reputation of PLOS, the EPBN primarily attracts individuals who support the mission of the PLOS organization or the Science 2.0 movement. Individuals that choose to participate in the Network help (in some capacity) to facilitate open and purposeful conversations about scientific research and news.

Limitations of findings

The findings from this study are limited by the scope of the data collected during the research period. One blog network was examined and the findings were not cross compared to other networks. To collect a manageable amount of data, only the most recent six months of content from the EPBN was analyzed. Examining more than one blog network or sampling data longitudinally would likely have been more informative as to how this type of community practice evolves over time.

The time parameters of the research period excluded what could be influential blogs within the EPBN: The Guest Blog and MIT SciWrite, which is authored by student in the Institute's graduate science writing program. At the time of the study, this blogs represented the only opportunities for community participants other than PLOS-sanctioned bloggers to publish posts (the EPBN has since added the blog EveryONE, which interested participants can submit work to PLOS to be published as a post.) The Guest blog has been inactive since October 2012; MIT SciWrite was reactivated in the 2013 fall semester. Both blog could serve to challenge the hierarchical power structure that persists across the Network.

With respect to the interview data, there was a low response rate to participate in this study. Only bloggers were interviewed and scientists were overrepresented in the sample

compared to medical professionals, journalists, educators or others. This meant that the entirety of data relevant to commenters had to be inferred. The anonymity of the commenters restricted the extent to which insights could be gained about the demographics of these participants. In addition, the fluidity of the commenters throughout the research period was a barrier to understanding their motivations and goals within the Network as compared to the bloggers.

Finally, there was minimal access to the social media shares of the participants due to privacy setting on their Twitter, Facebook, and Google+ accounts. Access to this data would useful in two ways. First, the social media data, combined with comment data, would serve as better indicator of the scope of the discourse that is initiated by the blog posts. Second, because social media commentary cannot be mediated by the bloggers, this data may have provided more insights into their true opinions about science, their grasp of scientific information, or their own abilities to create scientific knowledge.

CHAPTER 6: CONCLUSION

Overview

This study explained the cultural practice of the EPBN with the intent of gaining insights into how online environments fit into the current sphere of science communication. Internet technologies provide the science community with an array of new tools and capabilities, and it has been generally accepted that those technologies present novel possibilities for sharing and discussing scientific information. However, the dominant narratives that have emerged around online science communication environments have mostly served as overly optimistic speculation, with little empirical analysis of the technical or social structures of the platform to support relevant claims.

This study joins few others that have attempted to punctuate those dominant narratives with data-based research. The findings from the EPBN represent an opportunity to dissect science blogging from a number of angles. From a cultural perspective, the Network brings blogging, a 21st century development in science communication, in direct contact with the 20th century's best known science communication endeavors, journalism and academic extension. From a social perspective, it serves as a communal environment where science-minded individuals can meet and interact based on similar, knowledge, interests and affiliations. From a technical perspective, it rests on an infrastructure that utilizes digital resources, specifically blog commenting and social media, to facilitate intra- and inter-community interactivity.

This study focused on the EPBN's practice because 'practice' has cultural, social and technical interpretations across an array of academic disciplines. This study was exploratory,

and though certain assumptions were made about the EPBN in the early stages of the research to guide the analysis, it was the concept of practice that anchored the characterization that was produced. Wenger's CoP model is particularly relevant to the Network because it asserts that people contribute their individual knowledge and talents to a community, and through their interactions in the space they create effective norms and traditions.

In line with Wenger's conceptualization of practice, the EPBN should be understood as a space that is a continuing consequence of a particular intersection of people, technologies, and circumstances. To generalize the findings from the Network to another science blog network would offer the risk of minimizing the unique qualities contained in either group. However, the Network as a case study does stand to further inform the present body of online science communication literature by suggesting how blogs have been integrated into the media landscape, and to what extent that are affecting (and being affected by) other subcultures.

What follows are the implications of the EPBN to the broader scope of science communication, as suggested by the study's findings. This discussion serves to exemplify and make more tangible some of the ideas, criticisms and questions that have been associated with online communication environments in this context.

Situating online communication environments on traditional-modern spectrum

There is a major tension within the EPBN between how it defines and achieves its shared goals. The PLOS organization defines the Network as progressive space where communication is practiced in ways that run counter to those of traditional media environments. At the same time, the defining features of two traditional science communication subcultures are the most influential to the Network's socializing and publishing norms.

The blog network described in the EPBN's mission statement has indicators of open and democratic enterprise. The network was created for the purpose of allowing individuals to coalesce and speak candidly and informally about science. In addition, the Network intends to be open wide range of opinions and ideas about science, medicine and technology.

The Network aims to be forward thinking, but this intent is (actively and passively) dampened at the organizational and individual levels. At the organizational level, PLOS utilizes EPBN as a business venture, and the affiliation overshadows the 'independence' of the Network. Although the EPBN is only affiliated (and not managed) by PLOS, the name recognition that accompanies the PLOS brand affords privilege the Network that is similar to other mainstream science media companies. As a consequence of this privilege, the Network as a whole is biased to uphold the professional and social norms that accompany mainstream media culture.

At the individual level, the downstream transmission of information that occurs within the EPBN serves to empower those that have been traditionally visible in science communication. Elite scientists and journalists are the most respected figures with in the Network; as a consequence, they are also the active and visible publishers of content.
In some ways, the enhanced publishing privileges of the bloggers benefit the quality of the discourse that takes place on the blogs. Overall, the amount of trolling in the blogs' comments was minimal; when comment discussions did occur, they generally purposeful and substantive. While it could be argued that the bloggers are patronizing figures within the Network, their moderation efforts keep the focus of their blogs' discourse on science and eliminate contributions that do not intellectually serve other participants.

At the same time, the bloggers' moderation makes the patronizing figures within the EPBN. At their own admission, many of the interviewed bloggers see their comment moderation as a requirement for civil and constructive discourse on their blogs. Their moderation makes more severe the power dynamic between themselves and other participant by minimizing the agency of the latter group. In addition, the anonymity of the overwhelming majority of the Network's non-blogger participants serves to create a further suppressed audience that potentially mirrors the undervalued public described in the deficit model.

This practice within the EPBN suggests the Network occupies a unique place within the PLOS organization as an initiative that wavers between being traditional and modern. More broadly, it suggests that blog networks occupy a unique place on the science communication timeline, straddling both 20th century and 21st century theoretical conceptions of how scientific information flows through society. Applying solely the deficit model to the Network's communication neglects the contributions of nonexpert participants to the scientific discourse of the blog community. However, applying solely an engagement model to the Network's communication neglects the fact the nonexpert contributions are minimal compared to those of the traditional elite, and are only accepted as appropriate contributions because they have met the elite's personal standards of appropriateness.

The EPBN demonstrates that blog networks have the potential to expand both the form and function of science communication, and the formal networking of blogs could possibly strengthen that potential. However, the complex relationship that blog networks represent—between, institutions, individuals, and ideals—suggests that they may require significant time and negotiation between involved groups to before they can be accepted effective communication tools.

To do this, stronger collaboration is needed between thought leaders, practitioners and invested publics relevant to this area. These collaborations should serve to further define the objectives and functions of blog networks relevant to past and present forms of science communication. The EPBN suggests that disconnects between intention and execution of goals may limit online communication environments from reaching their full potential. Even if a blog network does not seem to suffer in terms of its collective traffic or participation, a more strategic operationalization of its mission statement may help it to develop into a more effective engagement tool for the associated media brand.

Traditionalism as a means of accepting online environments in science communication

The EPBN's incorporation of traditional science communication into its practice, specifically communication that fits the deficit model, allows it to maintain its professional integrity and credibility inside and outside of its network. Without these explicit markers of traditionalism, it may be more difficult for to accept the Network as reputable.

To date, conversations about blog networks have mostly provided personal anecdotes and historical accounts related to the emergence of the trend. The most in-depth analysis of blog networks on record is the aforementioned May 2013 WCSJ panel discussion. There, a common theme was presented across the discussion relevant to the origins of blog networks--that was that network were the consequence of the science community needing increased rigor and cohesion in the blogging to make the practice more competitive with other forms of science communication. Panelist Betty Mason from *Wired* said:

> "I think there's a need to set some kinds of standards, and we should have a discussion about that those standards should be. How we would set them? How would

> we encourage others to abide by them? Another discussion to be had is about ethics. I think that a lot of the ethics involved are the same as those involved with traditional journalism, but a lot of bloggers aren't trained journalists and haven't spent much time thinking about things like transparency and conflicts of interests. Thinking about these things will help with the continued credibility of science blogging and will help ensure that there continue to be host sites like *Wired* and *Scientific American* and *National Geographic*, who are taking a risk by having somewhat editorial-free voices. So if we can find ways to help those go forward, I think that will help."

Her concern with standards and ethics is important considering that she and her fellow panelists manage blog network emerged from a major ethical controversy in their field. The downfall of ScienceBlogs, which imploded because of a fierce clash of ideals between administrators, bloggers and readers about the role of corporate sponsorship in blogging, demonstrated that blog networks require ideological consistency across their participants to succeed. Further, it demonstrated that (to some extent) the traditional ethos of journalism and academia, which is rooted in the professionalism and objectivity, is still valued in new media environments.

That is to say, traditionalism may be required for blog networks to gain traction inside and outside of the science community. As Bora Zivkovic, who said of his Scientific American blog network during the WCSJ panel:

> "...Things happen when people from their personal blogs or Wordpress spots to a popular platform where they have much more traffic, and the banner of Scientific American gives them some respectability that they would have to earn much harder on their own, out in the wilderness. So, one way that that we help them out is that every month we select

> about three blogs and we publish them in the magazine. Those are 'clicks' for them and it's very important, especially for the youngsters, to get those 'clicks.' Being published in *Scientific American* means something in this world…They have complete editorial freedom, which can be tricky when you don't have veteran journalists on your network. You have to kind of teach them--how to make catchy headlines so they get read, and things like conflicts of interest, and just basic journalistic ethics."

Ironically, later that year Zivkovic himself was involved in a situation that demonstrated to what extent his blog network was intertwined with *Scientific American* and upheld the professional traditions of the brand. In October 2012, Monica Byrne, science writer and colleague of Zivkovic, alleged on her self-titled blog that he had sexually harassed her at professional events (Sorg, 2013). Zivkovic quickly admitted to the offense and apologized on A Blog Around the Clock, in which he "expressed my deep regret to the company about acting unprofessionally (Zivkovic, 2013)."

Another writer, Hannah Waters, soon came forward with similar allegations as Byrne (Helmuth, 2013). On the heels of this negative press, *Scientific American* released a statement on October 18 saying that Zivkovic had offered his resignation for the company, and they had accepted (*Scientific American*, 2013). They expressed that his behavior as their blog network manager did not align with their corporate anti-harassment policy, to which they provided a link to their company's published code of conduct.

Zivkovic's resignation occurred in the context of another professional breach at *Scientific American*. Also in October, Danielle Lee, an African-American female scientists whose blog Urban Scientist is in the company's network, wrote a post in which she alleged that editor at the website Biology Online, a white male, called her an "urban whore" after she refused to published

on their website without financial compensation (Lee, 2013). Biology Online is in the same partner network as *Scientific American*, which may or may not explain why days after Lee published her post it was deleted from her website without her consent or awareness.

Lee's allegations were verified by screen captures of email correspondence and the editor at Biology Online was eventually fired from his position. *Scientific American* insisted that their decision to remove the post was valid because the blog network was "a publication for discovering science" and that Lee's "post was not appropriate for this area and was therefore removed" (Hess, 2013). Still, the company received widespread criticism for their decision to commit was essentially considered to be censorship and the professional of it and its network was called into question.

Due to novelty of science blog networks, it is premature to say whether the October events at *Scientific American* should be considered outliers in the practice of science blogging. However, at the most fundamental level, those events demonstrate there are expectations--by the company, bloggers, and company--for a blog network to uphold the integrity of its affiliated or managing brand. "Integrity" in this sense is closely tied to the professional traditions that are associated with the older forms of science communication, like journalism. The *Scientific American* name has historically assured readers of a science communication practice that is accurate and respectable. This assurance allowed invested publics to trust in its blog network. The violation of that trust was a threat to the network's survival.

Although there have been no such extreme situations in the history of the EPBN, it is similar to the *Scientific American* network in that it exemplifies how traditionalism is a necessity for order and fairness in online communication environments. They may be appropriated by

mainstream brands to initiate something "new" or "progressive" for their companies, but it is likely that they first needs to gain the trust of users by infusing their networks with traditionalist ethics and standards, so these things can be used by all as reference point of professionalism.

Without these reference points, online environments may not be able to completely fulfill their potential visible and credible spaces. In addition, they may struggle to recruit and retain users, particularly those from the lay public, who are looking to be directed to quality scientific information.

"Selling" science through narratives

The EPBN bloggers utilized narratives to make their content more understandable, entertaining and engaging to their readers. This technique has origins in traditional science journalism practices. In explaining the process of "selling" science to various publics, Nelkin (1995a) describes how, historically, journalists have created narratives around science that emphasize human interests in order to appeal to audiences:

> "Journalists often cast the problems of technology in the form of myth of social drama. Communities (Love Canal) are threatened by evil. Normal institutions (departments of health) fail to deal with the threat. Villains (polluting industries) are identified and brought into line through redressive action. Supervisory institutions (government agencies) are responsible for cleaning. Solutions are sought in better technology (chemical and waste containment facilities) or through scientific knowledge (expert advisory panels). The message is our ability to win over the forces that besiege

us." (p62)

Presenting compelling narratives is necessary mechanism for continuously re-casting science in the role of a society's savior. As Nelkin (1995a) says bluntly, journalists are in the "outrage business" (p.63). It is shock value that typically draws the eyes of readers, whether or not they support they are politically or socially aligned with the topic at hand. Dramatic stories where science is framed as the "hero" contributed to a continuous narrative arc that science can fix societal issues through the efficacy of its system. This "sells" the desired message that science as the ultimate source of authority.

As representatives of the formal and broader scientific community, and also affiliated of PLOS, it could be assumed that the EPBN bloggers have an implicit responsibility to positively market science to their readers. Within the sample, the bloggers tended to write about newsworthy stories in the field, like new research findings, major professional gatherings, or contested ideas and theories; these types of stories contained elements of drama, suspense and tension that could emotionally engage readers. Even when the bloggers discussed more mundane aspects of the field, like field site visits and lab work, they often used the technique of casting themselves (or other individuals) as "characters" and couching the events in engaging narratives that followed an exposition-climax-resolution format.

According to narratologist Christian Salmon (2010), it is the element of engagement that is crucial for marketing products, ideas and values to consumers. He speaks of the process of "relational marketing" where the goal is to not only make the consumer desire a brand, but also feel involved with brand's story:

"For that [relational marketing] to happen, the brand must rediscover a strong and

> coherent identity that speaks to consumers as well as to the company's collaborators--employees, shareholders, suppliers, investors—and condense all the elements that go to make up the company into a coherent story: its history, the nature of the products it makes, the quality of its customer care, labor relations, and its relationship with the environment." (p. 22)

The respective mission statements of PLOS and the EPBN help to establish the identity of the Network to readers, but expressing the history, values, and some of the goals of the blog community. Beyond that, it is the bloggers' posts, and the narratives that are spun from them, that help build the ever-evolving "story" of the Network's brand. The fact that readers can participate in the story—by commenting on and sharing content—allows them to become relational consumers of scientific information. With that, they are not only consuming science, but also the (idealized) notions that science is accessible, communal, and democratic.

According to Salmon, narrative marketing tactic allow brands to remain visible and relevant in an age when so many cultural dimensions are fractured:

> "It has become commonplace to to speak of the fragmentation of values, the loss of points of reference and the shattering of codes of behavior; consumers are no longer attracted to products, or even lifestyles, but they are attracted to 'narrative worlds." In times of economic crisis, when nostalgia marketing invokes recurring memory of some golden age, it mobilizes worlds that rely heavily on narratives." (p. 24)

In this sense, storytelling allows the bloggers, and thus the EPBN as a whole, to develop a brand that is cohesive and continuous. This could potentially be a boon to the Network as a communication endeavor since it has to survive in an increasingly splintering media system.

Participants in the EPBN have a wide variety of other websites and blogs from which they could find scientific information, so it is necessary for them to build a report with the EPBN brand to ensure their long-term commitment to the blog community.

Some of the bloggers seemed to have a sense of this. Ricki Lewis, who utilized narrative arcs in nearly every sampled post, spoke of how she felt that storytelling was a helpful tool for serving the mission of her blog, which is putting "genetics in context":

> "You have to make connections that not only make sense to you, but also your readers. That's why I try to inject anecdotes from my life, or real-life stories from the news…people can relate to that. They can tie themselves to genetics rather than just learning about it. And that's more fun for everyone."

The "fun" that comes from engaging with a story contributes to the greater narrative of her blog. From a marketing standpoint, it also serves as an entry point to the greater narrative of the EPBN brand. According to Salmon, brands are "vectors for 'worlds'" (p.29). These vectors lead consumers into fictional stories that has been scripted and developed by the marketers. In this sense, every post produced by the bloggers is a "sales pitch" for themselves and the EPBN.

More broadly, storytelling may be a useful tactic for marketing science as an institution to the EPBN's participants. According to Salmon, storytelling is the most useful technique for converging perspectives from various social, political, and religious perspectives:

> "Storytelling marketing is, by its own admission, an attempt to synchronize 'worldviews' that may well be antagonistic in political or religious terms, but which can be reconciled on the great stage of the world market. The exercise of consuming then becomes an exercise in global communications or even communion." (p.29)

Because science is fraught with various cultural tensions, consuming science through stories may offer an opportunity for information seekers to more easily navigate the conflicting ideas and images that are being marketed to them. By engaging with a brand and its story, information consumers are in some sense conceding some of their differences to buy into a constructed shared narrative about science. If the narrative mirrors the prevailing values of the science community, then the community has achieved the first steps of "selling" itself to the public.

Blogs as bridging tools within the scientific community

Blogs have been framed as opportunities to link the formal scientific community to the lay public, with the "window" and "bridge" conceptions being the most popular. However, the EPBN is a community comprised mostly of individuals who have some varying degrees of science literacy. Missing from the community seemed to be the lay citizens who were ignorant or uninterested in science.

The "window" or "bridge" conceptions may be an inappropriate fit for the EPBN. The blogs are open webpages that contain relevant and accessible scientific information. Still, the Network seems to more serve the purpose of communicating to individuals already involved or interested in science than it does connecting those individuals with other who are unconverted.

Specifically, the Network seems to align journalism and academia in such a way that more easily allows science writers and research scientists to interact and influence each other. In this space, the two are essentially performing the same duty—translating science to audience—using the same toolbox of technical and social resources. As a consequence, audiences can enter the space and access information that is tangentially endorsed by the two established

cultural institutions in science communication, which creates more room for trust in published content.

This suggests that blog networks can potentially be useful bridges inside of the scientific community, functioning to connect science-minded individuals from different subcultures. In an age when journalism is struggling to remain relevant and academia is seeking ways to be accessible, blogs could represent the intersection of opportunities for the institutions to both achieve their goals.

Matthew Eltringham, editor of the BBC College of Journalism website, argued in his November 2013 editorial for the website that journalism and academia should recognize in each other a crossover appeal, since they are (in his opinion) fundamentally similar. Although his piece was not specific to science disciplines, his ideas serve to address the sweeping media changes facing both institutions. He said:

> "Journalists and academics have an awful lot in common. We all have egos; we speak our own unique language; we all think we are right and the other guy is wrong; and we all want to make a difference...the two cultural institutions are facing similar challenges to the way they operate. Old-style 'fortress journalism' has been under relentless attack for some years from the changing digital and social frontlines. Meanwhile 'fortress academia' similarly struggles to maintain its traditional ways of working. The cycle of research, funding, writing, peer review, publication and citation are being challenged by all of the same digital and social forces that are assailing journalism."

He further argued that dismissing those forces as fleeting or trivial would only serve to dampen the cultural influence of each institution. He pushed the idea that instead, through

forming a partnership and collaboration, both institutions could more directly face the challenges of the current media generation. He said:

> "But if we succumb to that temptation we risk throwing away one of the key values that has to define our new relationship - one of relevance. These digital and social forces are the ones that are shaping our world now. We need to understand them AND use them in order to continue to connect to both an academic audience and a journalistic one.

The person within the EPBN who seemed most apt at breaking free of "fortress journalism" and "fortress academia" was blogger Ricki Lewis. Lewis, a veteran scientist, educator, consultant and writer in the field of genetics, had well laid connections in both institutions prior to the network space. However, DNA Science Blog is a space for her professional identities to converge. Further, she utilizes blog networking as a means to crossect her colleagues and patients for their professional and personal gain.

The success of Lewis in using her blog to work across boundaries in the scientific community and encourage others involved to do the same only exemplifies the potential of blogs in the capacity. As blogs and blog networks evolve as science communication tools, these relationships between those who are already science literate or invested in science should be more closely examined. These relationships may suggest how and to what extent subcultural institutions within the scientific community can be strengthened or reformed by interaction or collaboration.

Blogs as techno-social deterministic communities

The analytical methods adopted to this study from Dennen's characterization of "Blogademe" were themselves adopted from a model of online community interaction developed

by Nancy Baym (1995), a scholar of computer mediated communication (CMC) whose work sought to challenge early assumptions in that field. At the time, CMC research was dominated by a technology deterministic tradition. Baym's work with patient online communities (POCs) suggested that online communities were consequence of interplay between technology, human activities and context (Josefsson, 2005).

Assumptions of technological determinism shaped much of the literature about blogs in science communication. The focus from this perspective has been the commenting feature, and relevant conversations have strongly favored the notion that the two-way discourse between science experts and lay citizens will flow automatically because they are technically enabled to converse.

The EPBN challenges the technology deterministic tradition, as there is strong evidence from the findings that Network's practice was as equally influenced by its participants and its web pages. Commenting is a communal activity in the Network, but it is more likely to occur between non-blogger participants. The expert-nonexpert interactions are scant, unless a blogger is highly motivated to engage with his or her readers.

These finding were similar to what Dennen (2008) found in a comment-oriented study in the "Blogdame" series. Within this network, comments between readers primarily served the function of sharing information related to blog content. By contrast, comments from bloggers served the function of attending to the needs of the readers.

With respect to the EPBN, two social factors may be influencing what seems to be an overall lack of commenting between bloggers and non-bloggers. As suggested by the interviews, time and energy are significant constraints for the bloggers. They were motivated to comment only when they felt it to be absolutely necessary, usually when they were required to moderate.

Also suggested by the interviews is that the bloggers hold strong views about the about the roles occupied by themselves and others in the Network. The bloggers perceive themselves as the community experts and consider their blogs to be personal property; by contrast, they perceive their readers to be nonexperts and invited guests in the webspace. This perception may dampen the bloggers' interest in participating in an activity that, in theory, facilitates democratic discourse between all participants in a blog community.

If this is so, it would suggest that commenting within the Network is limited by the traditionalist attitudes of its most powerful participants. More broadly, it suggests that more than technical barriers need to be lowered to allow a full range of commenting to occur on blogs. To invite progressive interactions into a blog network, the technology should be approached by the progressive mindsets by its participants.

(Re)Defining the conceptual bounds of blogs and blog networks

The contributions of social media sharing to the EPBN are questionable. The high number of social media shares from each blog means that discourse relevant to the Network's content occurs outside of what is considered to be its physical bounds. What cannot be determined is to what extent this discourse is expanding or amplifying the Network's community structure and dynamics.

What happens between participants in the EPBN, the individuals in the broader social networks, and the shared content from the Network can only speculated at this point. It is likely that social media shares induce more relevant discourse, but the duration and substance of these conversations would need to be examined to understand if this communication mimics or challenges that of the Network's comments.

In particular, it would be interesting to the present study to analyze the Twitter shares that occurred during the data collection period. Twitter was the most utilized of all the Network's social media plugins and consistently mentioned by bloggers across the interviews as their discursive tool of choice. Twitter also has the unique contingency of limiting communication 140 characters, so the depth of conversations would likely be constricted.

If Twitter is indeed a fundamental component of the EPBN's community discourse, it may be worth renegotiating the conceptual bounds of the Network to include shares to the platform, as well as other impactful social media. Twitter may be an integral component to the Network instead of one that runs parallel to its activities.

Beyond the scope of the EPBN, this issue introduces several questions: How do the individuals in the broader social networks of participants engage with the content from a blog network? By proxy, are these individual participants in the blog network as well? Also, once content is expelled from the physical bounds of the blog community to Twitter, is it still considered part of the network? Should Twitter dialogues that are related to the network's content still be considered local?

As Twitter-focused research is becoming a growing body of online science communication literature, there is room to explore these questions in the future. Twitter has frequently been categorized by science communication scholar as a blogging sub-type--"microblogging"--in which communication is comparably smaller and more portable. Investigations into the practice of posting and sharing small piece of digital content, especially when that content has ties to other website or online network, would offer more insights into how the platform serves as a functional and relevant resource.

Recommendations for future research

It would be beneficial to future research involving the EPBN to analyze longitudinal data. This could involve sampling blog content at intervals over an extended research period and also conducting multiple interviews with bloggers. Also, if possible, interviews should be conducted with non-blogging participants who are willing to share information about themselves and their experiences. This could be commenters or individuals who choose to passively engage with the with the Network's website. Discussions with these individuals are necessary in order to more accurately gauge who is participating in the EPBN and why they choose to do so.

Future scholars that examine the EPBN may want to reconceptualize the physical bounds of the Network to include other social media websites, in particular Twitter. As previously, discussed, if constructive discourse relevant to content published on the Network's website can be supported through social media, it may be necessary to identify and track participants who regularly engage in these activities. Understanding how social media facilitates the connectivity of the Network's participants and their ability to share and discuss information could potentially lead to a renegotiation of what is considered its internal and external community discourse.

Finally, a cross comparison of practices between the EPBN and other mainstream-level science blog networks could possibly produce more generalizable findings. The Network is comparable in size and visibility to other current blog networks, like those associated with Wired, National Geographic and Nature. Identifying the participants, processes and norms within one or some of these other blog networks would be a step towards building a more robust image of the practices that occur within science blog communities. Also, because some of the aforementioned companies are legacy media brands within academic and popular science

publishing, a cross-comparison study would serve as an additional opportunity to evaluate if and to what extent traditional science communication practices have been integrated into modern communication environments.

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APPENDIX A: TABLES AND LISTS

Table 3.1: Blogs and bloggers within the EPBN

Category	Blog Name	Blogger(s)	Topical Focus
N/A	The Guest Blog	Varies	Varies
ARCHIVED	Genomeboy	Misha Angrist	Genetics
ARCHIVED	Speakeasy Science	Deborah Blum	Chemistry
CULTURE	Gobbledygook	Martin Fenner	Technology
CULTURE	The Language of Bad Physics	Sarah Kavassalis	Mathematics/Physics
CULTURE	At The Interface	Johanna Kieniewicz	Art/Science
CULTURE	Citizen Science	Lily Bui (Lead)	Public Engagement with Science
CULTURE	Sci-Ed	Cristina Russo (Lead)	Science Education (Formal and Informal)
CULTURE	The Panic Virus	Seth Mnookin	Science Communication
CULTURE	Wonderland	Emily Anthes	Evolution
CULTURE	MIT SciWrite	Varies (By semester)	Science Communication
ECO	All Models Are Wrong	Tamsin Edwards	Climatology
ECO	Integreated Paeleontologists	Andrew Farke (Lead)	Paleontology
ECO	The Gleaming Retort	John Rennie	Environment
ECO	Tooth and Claw	Hillary Rosner	Environment
HEALTH	Obesity Panacea	Peter Janiszewski and Travis Saunders	Health/Obesity
HEALTH	Take As Directed	David Kroll	Pharmacology
HEALTH	This May Hurt A Bit	Shara Yurkiewicz	Medicine
HEALTH	DNA Science Blog	Ricki Lewis	Genetics
HEALTH	Public Health Perspectives	Atif Kukaswadia (Lead)	Pubilc health
HEALTH	Body Politic	Melinda Wenner Moyer	Health and policy
HEALTH	Work in Progress	Jessica Wapner	Biomedicine
HEALTH	Translational Global Health	Alessandro Demaio	Global health
NEURO	Mind the Brain	James Coyne (Lead)	Psychology/Psychatry
NEURO/CULT.	Neuroanthropology	Daniel Lende and Greg Downey	Nuroscience/Anthropology
NEURO/CULT.	NeuroTribes	Steve Silberman	Neurology

Note: Blogs highlighted in gray were excluded from the analysis.

Table 3.2: Interviewed bloggers featured in results and discussion

Blogger(s)	Expertise	Date of Interview
Misha Angrist	Genetics	7-Feb-2013
Martin Fenner	Technology	5-Apr-2013
Lily Bui (Lead)	Public Engagement with Science	16-Apr-2013
Seth Mnookin	Science Communication	8-Apr-2013
Andrew Farke (Lead)	Paleontology	26-Apr-2013
John Rennie	Environment	9-Feb-2013
Travis Saunders	Health (Obesity)	30-Apr-2013
David Kroll	Pharmacology (Oncology)	23-Mar-2013
Ricki Lewis	Genetic Counseling	10-Apr-2013
Greg Downey	Neuroscience/Anthropology	11-Mar-2013

List 3.1: Semi-structured questionnaire for bloggers

1. Can you tell me how you started blogging for the EPBN?
2. What would you say is the purpose of your blog?
3. Do you feel that, as a blogger, you are a member of any particular communities? Can you define them or describe them for me?
4. Can you tell me about the readers/commenters on your blog?
5. In what ways do people participate on your blog? How have the various forms of participation contributed to the current state of your blog?
6. Can you tell me about the information produced on your blog? What do you think your readers learn from you? Have you learned anything from your readers?
7. Can you tell me about any rules that are in place to manage or enhance blog participation?
8. Does your blog utilize any "tools", i.e., any particular resources or processes that helps to facilitate more participation and a better blogging experience?
9. Do you or your readers/commenters ever challenge the "normal" protocol of blog participation? If so, how?

APPENDIX B. SELECT BLOG POSTS REFERENCED IN DISSERTATION (TEXT)

Title of Blog: DNA Science Blog
Title of Blog Post: Comparing Adam Lanza's DNA to Forensic DNA Databases: A Modest Proposal
Author of Blog Post: Ricki Lewis
Date of Blog Post: January 3, 2013

(Note: Bolded words indicate hyperlinked text)

In 1729, Jonathan Swift of Gulliver's Travels fame published a satirical essay called **"A Modest Proposal**." He suggested that a cure for poverty was for poor people to sell their children to rich people as food.

I'm borrowing Swift's essay title to bring up another outrageous idea: analyzing forensic DNA databases for a genetic signature of criminality.

ADAM LANZA'S DNA

Days after the Newtown shootings of December 14, 2012, headlines trumpeted the **state medical examiner's** request of University of Connecticut geneticists to examine mass murderer Adam Lanza's DNA. What exactly that might entail wasn't announced, but **celebrity docs**, geneticists, and bloggers weighed in, nearly all agreeing that (1) violent tendencies are due to complex interactions of many genetic and environmental factors and (2) probing Lanza's DNA and finding anything even suggestive of causing his crime could lead to stigmatization of individuals who share suspect genome regions with him.

Behind the denials of a genetic explanation for criminality lies a history of just such associations.

Past candidates for criminal DNA, listed in many articles last week, include the extra Y chromosome of the 1960s and the monoamine oxidase **monoamine oxidase** (MOAO) mutation behind a Dutch family of arsonists and rapists, described in 1993. Shortly after, researchers identified a different gene variant that tracked with violence and suicide in Finnish families.

A year ago, criminologists published a study that applied a **"delinquency scale"** to assess whether such behaviors as painting graffiti, lying to parents, running away, and stealing, were more likely to affect identical twins than fraternal twins, suggesting a genetic component. The headlines that the article in Criminology spawned, with the help of news release hype, were predictable: "Life of crime is in the genes, study claims."

If an investigation of petty crimes inspires these headlines, the fear of unleashing genetic

discrimination from Lanza's DNA analysis seems justified. Yet it appeared odd to me that several articles deemed any response to the sequencing of the killer's DNA unlikely, because it would be a sample size of one.

We do, in fact, have sources of criminals' DNA. And they're extensive.

ENTER FORENSIC DNA DATABASES

A blog from the **Council for Responsible Genetics**, for example, claims that "Focusing on the results of the study [on Lanza] could also prove problematic since there is (sic) basically no data to compare it to," then quotes a University of Massachusetts Medical School professor saying "we don't have enough of a sample size."

But forensic DNA databases in many countries have been storing the DNA of convicted criminals since the mid-1990s, many killers among them.

The UK led the way in DNA profiling (I wrote the cover story on it for **Discover** in June 1988), and their National DNA Database now has samples from more than 6 million individuals.

In the US, the Combined DNA Index System (CODIS) has more than 10 million samples. **Thailand** just signed on to use CODIS on voluntary samples from 100,000 inmates, and 39 other nations already use the system.

CODIS generates a DNA profile for an individual based on 13 sites in the genome that vary in the number of repeats that they harbor. One such "short tandem repeat" (STR), for example, includes the DNA sequence "GATA" present in 5-16 copies on each of a person's two chromosome 7's. For that marker alone, 78 combinations are possible. Multiplying the frequencies of the different variant (allele) possibilities in a particular population for all 13 markers generates enough diversity to distinguish individuals.

Within the STR DNA profiles of these millions of convicted individuals may emerge a genetic pattern that's more common among mass killers like Lanza. Maybe significantly so. If researchers have access to **DNA samples**, and not just CODIS profiles, they could, theoretically, compare any part of the genome. If there is such a thing as measurable inherited criminality, then as the numbers build in the databases, then associations between DNA patterns and certain behaviors may strengthen, perhaps suggesting a mechanism that can be used in drug discovery or repurposing.

A very large control group would also be necessary to weed out potential false positives, like showing that a disease-causing mutation is found only among patients.

DNA forensic data could and should be de-identified, because the crimes are important, not the names. According to the **FBI CODIS factsheet**, "If all personally identifiable information is removed, DNA profile information may be accessed by criminal justice agencies for a population statistics database, for identification research and protocol development purposes, or for quality control purposes." And informed consent isn't required of convicts.

Would use of a genetic signature for criminality plunge us into the world of Minority Report, the 2002 Tom Cruise film in which police in a dystopian society arrest people before they've committed crimes? I would hope not. But I can imagine a scenario in which a psychiatrist uses such a genetic test for a patient whose background suggests violent tendencies. The patient wouldn't suffer Tom Cruise's fate of premature punishment, but perhaps wouldn't be allowed to purchase a gun.

TARGETING MINORITIES?

A powerful argument against the use of forensic DNA databases in crime research is that minorities such as African-Americans are overrepresented in prisons, and findings could be used in a discriminatory manner. This was the reasoning behind the yanking of NIH funding from a conference on "genetic factors in crime" in 1992 at the University of Maryland, with charges of it being a "modern-day version of eugenics" (which is actually timeless).

But times, and technologies, have changed. The 1992 objection to even investigating genetic factors in crime predates the **DNA Identification Act** of 1994 that led to forensic DNA testing by 1998 – now done in all 50 states. And consider the most notorious recent killing sprees. The perpetrator of the worst attack, at Virginia Tech in 2007, was Asian, Seung-Hui Cho. The Columbine killers Eric Harris and Dylan Klebold were white, as is James Holmes of the midnight movie massacre in Aurora, CO in 2012. And the blurry, terrifying lone image of Adam Lanza is stark white.

I'm playing Devil's advocate here. I agree with other geneticists that looking for clues to the Newtown tragedy in DNA could do more harm than good. I also agree that environmental influences on behavior and personality are as important if not more so than inherited factors. But at the same time, I can't help thinking of those forensic DNA databases and the clues to violent behavior that they may hold, anonymously searchable by crime. And we now have the technology to derive much more information than we did when the technology was limited to selected repeats – we can sequence genomes. That's a lot of information.

WHY NOT?

Uses of forensic DNA technology are already eclectic enough to embrace investigation of a criminal tendency profile.

STR typing has been used to identify disaster victims, to reunite Holocaust victims with their

families, and to identify kidnapped children. And DNA profiling of footballs from Super Bowl games protects a vulnerable public against sports memorabilia fraud.

So despite lingering apprehension from the history of eugenics in the US in the early twentieth century, the threat of stigmatization, and growing acceptance of genetic determinism as genetic testing and genomes/exome sequencing become more widespread, I'm going to make that modest proposal.

I think that the DNA forensic databases may be important sources of information on the role, if any, of genetics in predisposition to violent behavior.

We have the data. Why not take a look? It'll keep bioethicists busy for years to come – and might prevent a crime.

Title of Blog: The Integrative Paleontologists
Title of Blog Post: And This Is Why We Should Provide Our Data
Author of Blog Post: Andrew Farke
Date of Blog Post: January 25, 2013

(Note: Underlined words indicates hyperlinked text. Bolded words are emphasized terms.)

For a long time now, I've been beating the drum of "provide your data." If you're willing to take take a whole mess of measurements and do a whole bunch of analyses for a published paper, why not share the raw data? New techniques and research questions continually arise, so it can be invaluable for other workers to be able to draw upon previously published databases. Although the situation is improving, it's still far from perfect. Even today, I'm somewhat embarrassed to point out that some articles in PLOS ONE (a journal whose mission I support as advocate and volunteer academic editor) don't provide relevant supporting data (recent examples here and here). But rather than dwell on the negatives, I want to point out a recent case study (also in PLOS ONE!) where data reuse benefited authors, journals, and science as a whole.

Derek Larson (now a graduate student at University of Toronto) and Phil Currie (a paleontologist at University of Alberta) published a massive paper in PLOS ONE concerning the identity of carnivorous dinosaur teeth. Paleontologists have a love/hate relationship with these teeth. On the one hand, they're cool and pointy and fierce-looking. There's nothing more thrilling than finding a tyrannosaur tooth! On the other hand, teeth kinda stink when it comes to species identification. A dromaeosaurid ("raptor") tooth is a dromaeosaurid tooth, and you'll never be able to get down to species level in most cases. So, museums have drawers and drawers of teeth identified as "Tyrannosauridae" or "Troodontidae" or "Dromaeosauridae". To make matters worse, the delicate skulls and skeletons of many of these carnivores (which are useful for identifying species) are pretty stinkin' rare.

These vague tooth identifications are problematic for issues of paleoecology and evolutionary interpretations. Let's say you have three different rock formations with dromaeosaurid teeth, spanning 10 million years of geological time. They all look pretty much the same, but it's almost certain they represent multiple species (evidence from skeletons shows that dinosaur species just didn't stick around for very long–a million years or so at most). This is a problem!

So the big question here is: can we actually find evidence that a dromaeosaurid tooth from the Hell Creek Formation (~66 million years old) is (or isn't) the same species as a superficially similar tooth from the Dinosaur Park Formation (~76 million years old)? Or are teeth just totally useless? Fortunately, Derek and Phil found a clever work-around. By compiling measurements from over 1,200 different dinosaur teeth, they developed an analysis to look at the overall shapes of teeth from each formation. There is strength in numbers! It turns out that even though the teeth are superficially rather similar, there are subtle discrepancies in measurements between the teeth from rocks of different ages. This is thus consistent with different species at different time intervals. In other words, that dromaeosaurid tooth from 66 million years ago is probably not the same species as that tooth from 76 million years ago.

Here's the really cool part: Derek and Phil were able to do their analysis so thoroughly and with such a large sample because other authors published measurements for theropod teeth! Although

many measurements were original to the PLOS ONE paper, the great majority were from previous studies. Folks like Julia Sankey have released countless data tables of tooth measurements, mainly as a way to describe characteristics of particular specimens. Previous authors may not necessarily have been thinking of the type of analysis implemented by Derek and Phil, but nonetheless released data for others to see and use.

This is a **win-win situation for everyone**. Researchers **Larson and Currie** were able to merge the previously-published data with their own new data into a monster analysis (1,200+ data points, remember) that significantly advances **science as a whole**. These generous previous authors saved Larson and Currie perhaps months of work and thousands of dollars in museum travel! The **previous authors** also win, through increased utilization of their hard work as well as another citation for their papers. And at the basest level, the **journals** that allowed and encouraged massive data tables (either as supplementary information or in-text tables) win through an extra citation (which helps the almighty impact factor).

Derek and Phil are also paying it forward–all of their supporting data are accessible. If you want to re-run the analysis tonight, or add your own data, or whatever, you can do it! Here's a big thank you to all of the folks who advance science by improving data sharing.

Citation

Larson DW, Currie PJ (2013) Multivariate analyses of small theropod dinosaur teeth and implications for paleoecological turnover through time. PLOS ONE8(1): e54329. doi:10.1371/journal.pone.0054329 [open access]

APPENDIX C. SELECT COMMENTS FROM THE EPBN (TEXT)

Title of Blog: The Gleaming Retort
Title of Blog Post: Evolved Fists or Best Weapon at Hand
Author of Blog Post: John Rennie
Date of Blog Post: February 26, 2013
Author of Comment: "Cade DuBois"
Date of Comment Post: February 26, 2013

(Note: Typographical and grammatical errors uncorrected)

Given that slamming your fist into the face of another human, as that pic shows, is one of the surest ways for a human to contract a serious, incredibly painfully and potentially fatal infection–via the mouth of the other human, especially if we're talking pre-dental hygiene hominids (seriously, primate mouths are nasty petri dishes!)–I say probably not.

Curiously, this risk is lessen by one not being able to make a firm fist, like other primates, so you can't cause as much damage to *your own self*. The higher risk of an infection via an open wound that allows nasty microbes that you likely couldn't get any other way to access to your soft tissue and blood steam seems to make using one's fist as a fighting tool, in addition to all teh various risks of serious fractures and soft tissue damage that could easily leave you in chronic pain if not with an unusable hand/wrist, seems like an evolutionary impediment, frankly.

In the animal world, fighting done for courtship is often done with the intent to intimidate and only superficially wound the opponent at the most. It's rarely to the death. The point is to breed, not die. Fighting for protection often requires a different set of skills, as well as a healthy dose of knowing when to flee. Likewise, most predators, although impressively armed, will err on the side of self-perservation–no point in taking down a rhino or a gazelle is you end up fatally wounding yourself in the process. Human aggression is quite different–it's innovative, it's adaptive, it does not solely rely on physiological evolution but also on a different tier of evolution: what we are able to acchieve through creativity.

But of course, as is typical of humans, sometimes the solutions and ideas we come up with isn't in our best interests. Chances are, we probably have been using our fists as weapons for as long as we have had them, because we needed something to hit the other guy with and it's what we came up with on the spot. But it's important to note we lost some of the evolutionary failsafes that keeps other primates from critically injuring themselves when fighting. For example, since we're on this topic, we evolved much for sophisticated hands, which, thanks to our more sophicated use of them, we are both more dependent on them as well as far more prone to injure them, thus we must protect them more vigilantly than other primates. That suggest smart humans would protect their hands, while stupid one would use them as weapons. Additionally, in order to develop speech, we lost that impressive ability to scare to crap out of each other by baring a mouthful of fangs, and somehow words just don't have that same visual impact when trying to intimdate an opponent before things get injurous. So we had to fall back on our creativity to compensate and thus we culturally developed so many rituals and stylized ways for fighting and combat, as well as weapons and armor. We likely figured out through trial and error (and various

instances of deadly infected knucklebones) that simply punching each other was never in our best interests–and yet, we still do it. ‘Cos we’re pretty stupid like that. But at least we invented boxing gloves. Progress!

But how did we evolved fists as we have? That is a good question. But I think evolutionary scientists like Morgan and Carrier need to think more broadly and with less bias than “What do men do with their fists?” Sometime, I swear, evolutionary scientists just assume masculinity is the sole driving engine behind evolution. But that’s another issue for another day…. Anyhow, if we assume that roughly 50% of any hominid population at any point in our evolutionary lineage wasn’t male, what female hominids do with their hands very likely had a big, big impact on our “manual evolution”. Likewise what communal activities male and female hominids did together probably was a hughely important factor too. Ponder that the next time you see someone “speaking” in sign language or gesturing while talking, or when you are writing something with a pen or pencil. More sophisticated communities would have needed more sophisticated communication, and that surely would have required more sophisticated tools, yes? And what would be more evolutionarily advantageous in that case, especially for a species what was developing an unprecedented capacity for creativity and social/psychological complexity? Using your sophisticated hands to grip a writing tool or to make a nuanced variety of communicative signs, or smashing it into some dude’s teeth?

I’m not scientist, by the way. But I am a musician–guitarist, lutenist and pianist–and so I know quite a bit about how humans use their hands, not to mention a good deal about hand anatomy (it helped that my father was PhD of Human Anatomy and I grew up around his textbooks). It will take a lot more than this to convince me we evolved the ability to make a firm fist so to hit each as opposed to giving our hands more strength and vastly finer dexterity so we could do the many creative and communicative things we humans do.

Title of Blog: Sci-Ed
Title of Blog Post: Can you worry about an animal you've never seen? The role of the zoo in education and conservation.
Author of Blog Post: Cristina Russo
Date of Blog Post: March 13, 201
Authors of Comment Posts: "Moos," "Lori Marino" and Cristina Russo
Date of Comment Posts: March 17-19, 2013

(Note: Underlined words indicate hyperlinked text; Typographical and grammatical errors uncorrected)

Moos *(*March 17, 2013 at 7:23 pm): I would like to congratulate you with this well-written blog about the role zoos can play with regard to education and conservation. Personally I think that most of the zoos' education or perhaps better put 'the education provide by most zoos' is a bit infantile and too much focused on children. It is about time that zoos will promote themselves as education and conservation institutes by addressing the various individuals that visit their premises. This means that the information provided should be diverse and provides more (scientific) depth when it addresses adults.

Your blog deserves a broader audience I think, so I posted it on my own website. Many thanks for sharing your thought with us.

Lori Marino *(*March 18, 2013 at 2:53 pm): Dear Moos: I appreciate the sentiment that zoos should plays a major role in education and conservation. After all, they advertise themselves to be places for both of these to occur. But as I mentioned in my comment, I have done research on the educational claims of the zoo and aquarium industry, published papers on this point and presented this work at numerous professional conferences and can tell you unequivocally that there is no scientific peer-reviewed support for the claim that visiting zoo displays are educational in any meaningful sense of the word. The evidence just isn't there. The problem is that the surveys and polls that the zoo industry conducts to make the claim are either too methodologically flawed to support that claim or do not directly assess education and attitude change. They assess what people "believe" they've learned but not actually what they've learned. None of the polls show any long-term retention of information on the animals or evidence that seeing the animals in a display has led to substantive conservation efforts. Again, the evidence doesn't exist. So while your points about broadening the audience and diversifying the "educational" opportunities are well taken, they are premature because there first needs to be some evidence that animal displays are educational for anyone. Thanks.

Cristina Russo (March 18, 2013 at 3:16 pm): Thank you both for your comments. In my post I'd like to stay within the topic of education, and I mention some peer-reviewed papers in that subject. I'd gladly read the ones you point out, please feel free to leave the links!

Lori Marino *(*March 18, 2013 at 3:53 pm): Dear Christina: My comments are entirely within the topic of the educational claims of zoos and aquaria. Here are some links supporting my

argument.

U.S. Congressional Testimony http://www.c-spanvideo.org/clip/732751
Peer-reviewed critique of AZA study http://www.english.gsu.edu/pdf/AZA_Study.pdf

Thanks for your interest.

Moos (March 18, 2013 at 6:30 pm): Dear Lori, thanks for your response. The fact that you say there is no scientific peer reviewed support for the educational results claimed by zoos, does this mean that the claim zoos make is based on not-so-good methods to prove this claim (which you say you have researched) or is there also research with a scientifically sound method that proves that there is no educational worthwhile result. As these are two different things, aren't they. You can prove that something has been done wrong but that does not prove that the claim is wrong. Don't take this the wrong way, I just want to understand correctly what you say. So, I would like to second the question of Cristina about the peer reviewed papers you mention. Glad to read them. Many thanks.

Lori Marino *(*March 18, 2013 at 7:33 pm): Dear Moos: Good question. The education claim is based on weak methodology that does not support the zoo and aquarium industry's conclusions. This does not show the absence of education,but, the burden of proof is not on me. It is on the industry making the claim. If one makes a claim then one must have supporting evidence. That is all I am saying. See my replies to Christina for some of my publications on this issue. Thanks.

Moos *(*March 18, 2013 at 7:40 pm): Dear Lori, fair enough.

APPENDIX D. COMMUNITY GUIDELINES OF THE EPBN (TEXT)

Date: January 2013

- Don't post anything illegal. Seriously, don't do it. If we find you doing anything illegal, we won't think it's funny. Because, well, it's not. We won't try to understand. If you're one of our bloggers, we'll just remove your site. If you're a user of the site, we'll ban you. No questions asked.
- Please behave yourselves. Do we even need to say that? Blogs draw in diverse crowds, especially around polar topics and hot-button issues. Avoid name-calling, libelous comments, personal threats/attacks, which may be viewed by PLoS management or users as site abuse, and may result in suspension of your account.
- Don't plagiarize. The content that you upload should be yours. If it's not your content, or your content cross-posted from somewhere else, you should properly cite the source and observe fair use.
- If you leave a comment, you'll have to supply a username and a valid email address. No long registration process required. Fill out two simple lines, and your comment will be registered.
- About reader re-use of blog content. All blog posts published on PLOS BLOGS Network are freely available to anyone under an unrestricted CCBY 4.0 Creative Commons License requiring only attribution. With a CCBY license, the blogger keeps copyright but allows anyone to copy and distribute the work provided the individual blogger is given credit.
- Guidelines for Attribution. A good rule of thumb is to use the acronym TASL, which stands for Title, Author, Source, License. Title - What is the name of the material? If a title was provided for the material, include it. Sometimes a title is not provided; in that case, don't worry about it. Author - Who owns the material? Name the author or authors of the material in question. Sometimes, the licensor may want you to give credit to some other entity, like a company or pseudonym. In rare cases, the licensor may not want to be attributed at all. In all of these cases, just do what they request. Source - Where can I find it? Since you somehow accessed the material, you know where to find it. Provide the source of the material so others can, too. Since we live in the age of the Internet, this is usually a URL or hyperlink where the material resides.
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