

# **How and Why Physicists and Chemists Use Blogs**

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Christina K. Pikas

Doctoral Student

University of Maryland

College of Information Studies

### Abstract

This study examined how and why chemists and physicists blog. Two qualitative methods were used: content analysis of blog and “about” pages and in-depth responsive interviews with chemists and physicists who maintain blogs. Analysis of the data yielded several cross-cutting themes that provide a window into how physicists and chemists use their blogs and what value they receive from maintaining a blog and participating in a blogging community. The article concludes with a discussion of implications for supporting scientists’ work.

Author keywords: social computing technologies; blogs; informal scholarly communication; public communication; science communication;

Extensive research has been to understand how scientists communicate with other scientists, to policy makers, and to the public and to understand if and how information and communication technologies (ICTs) have changed scientific communication. We are now arguably in a second wave of web-based communication, one in which content is created by many more users, in a more distributed fashion, and is more easily shared. Scientists are near the leading edge of experimentation and use of these newer communication and online community building tools such as wikis, blogs, social bookmarking, and multi-user virtual environments.

One tool, the weblog or blog, is a listing of discrete posts in reverse-chronological order. Individual posts are authored as easily as e-mail, but then can be linked to, commented on, shared, searched, and aggregated in a community system. Blog software enables direct hyperlinking, commenting, and tracking of distributed conversations (Mortensen and Walker, 2002). Scientists have been using blogs for more than five years, but adoption has dramatically increased in the last three. This may be due to increased network effects<sup>1</sup>, or to two key events. First, for the anniversary of Einstein's Miracle Year in 2005, a consortium of physics organizations created a collection of blogs to teach members of the public about the daily life of high energy physicists.<sup>2</sup> Second, a publisher of a science culture magazine, *Seed*, started hosting many science blogs and sponsored conferences on science blogging.

Despite the fact that many scientists maintain blogs, we do not have systematic evidence of how they use blogs, why they use blogs, or how they perceive blogs' value. The purpose of this study is to explore how physicists and chemists from various settings and specialties use blogs for scholarly communication, informal scholarly communication, science communication to the public, and for personal information management (PIM).

## Introduction

Because of their support for immediate, open publishing, community building, and information sharing, blogs have tremendous potential to support scholarly communication and communicating science to the public. Scholarly communication includes formal communication of polished reports of completed work in journal articles and books as well as informal scholarly communication which includes other science-related communication.

Informal scholarly communication is vital to the advancement of science; yet, the impact of information and communication technologies (ICTs) on scholarly communication has been surprisingly limited (Glaser, 2003; Kling & McKim, 2000). Authors in the early years of the internet expressed hope that ICTs would broaden access to the invisible colleges and reduce peripherality as well as increase the rate of innovation by shortening the communication cycle and enhancing collaboration. Research has shown that the social aspects and the structural aspects of science are salient. Female scientists, scientists in minority groups, scientists in less developed countries, and scientists outside of large research institutions are disadvantaged in publication, grant-seeking, and in creating new scientific knowledge. Does blogging have a better chance of achieving some gains other ICTs have not? Can blogging improve the reach, effectiveness, efficiency, and participation rates of informal scholarly communication?

Communicating science to the public is vital to support sensible policy and funding decisions by the government and to create a well-informed democracy; but, except for a small number of “visible scientists,” many scientists have eschewed public communication, stating that they don’t know how to communicate with the public (Weigold, 2001). Further, there are concerns that public communication will take away from the peer-reviewed work that moves

science forward. Are the blogging scientists the same “visible scientists”? Have other scientists used blogs to engage a public audience? How do scientists view their audiences?

Beyond communicating with an unknown external audience, blogs can be used for PIM as research logs or as laboratory notebooks. Scientists might use blogs as diaries to work through research problems, document their work, and capture ideas for future research. Maintaining a notebook in a shared and searchable location might enable identification of future collaboration partners, might help other scientists learn from the author’s notes, and might increase awareness of the author’s work and skills. Electronic versions of laboratory notebooks have been available for several years; but they have not been widely adopted because they do not match the way many scientists work (Shankar, 2007). In addition, they do not support collaborative work or sharing of work in progress. Blogs may form a new mode of communication that crosses the personal with the public.

In terms of PIM, citation managers can be used to help scientists capture, save, and re-use research articles. Some newer citation managers allow users to share citations and participate in collaborative assignment of keywords for retrieval (i.e., tagging). However, these systems do not encourage scientists to annotate stored citations with critical commentary and frequently do not support the linking of citations to other work. Linking is done generally in completed papers, or commentary remains in a print notebook, inaccessible to other researchers.

In summary, it is not known how scientists use blogs or why. There could be great benefits to scientists’ blogging for their own learning, the advancement of science, and the communication of science to the public. An understanding of how and why these tools are used might lead to improvement of the tools, their wider adoption (and thus increased network effects), and better support for their use from science organizations.

## Literature Review

While there have been scholarly articles on blogs and blogging, few researchers have studied how scientists use blogs. This review highlights some of the findings from research on blogs, emphasizing blogs maintained by scholars. Studies of scientists' use of ICTs, particularly personal web pages and e-mail discussion lists, furnish background information. Several potential purposes of blogs drawn from the nature of blogs and scientists' use of personal web pages and discussion lists are also reviewed: PIM, informal scholarly communication, and public communication of science.

### *Blogs*

Blogs are widely defined as collections of individually authored discrete posts that are arranged in reverse-chronological order (Mortensen & Walker, 2002). Blogs use the technology of the web (e.g., html, RSS, CSS) and form an increasingly important part of the web (Lenhart & Fox, 2006). Yet blogs are more than just web pages because of their ease of use and support for interactivity and community.

Articles on blogs and blogging published in scholarly journals, books, and conferences proceedings fall into a few general categories: descriptive studies creating typologies of uses of blogs (e.g., Herring, Scheidt, Bonus, & Wright, 2004; Nardi et al., 2004); rhetorical studies of the language or communication in or across blogs (e.g., Trammell, 2005); studies of the political or journalistic implications of blogs (e.g., Carlson, 2007); and information retrieval from blogs (Mishne, 2007).

*Genres of blogs.* Herring *et al* (2004) performed quantitative content analysis of 203 randomly selected weblogs collected in 2003. They found that the majority of the blogs were

used as personal journals; additionally, blogs were used as filters for external information, as knowledge logs (project journals), and for “mixed and other uses.”

Walker (2006) described two types of blogs by academics: research logs and pseudonymous blogs about academic life. Research logs contain political discussions, records of ongoing research, and ideas to be pursued. Halavais (2006) extended her definition to include coffee house-like discussions of new research. Pseudonymous blogs describe getting jobs, working conditions in academe, bureaucracy, and teaching.

*Uses of blogs by scholars.* Earlier articles on the use of blogs emphasized their potential use for reflective writing practice. Paquet (2002) called this “personal knowledge publishing.” He described blogs as a tool to try out ideas; provide commentary; “keep a chronological record of your thoughts, references, and other notes that could otherwise be lost or disorganized;” get feedback; and engage in networking. Likewise, Mortensen and Walker (2002) described keeping blogs to reflect upon their work, to publish ideas, to assure getting credit for their ideas, and to connect with other researchers.

Recent articles emphasize blogging as routine or everyday. Gregg (2006) found in her field of cultural studies that there is a need for researchers to be accessible to the studied group. Whereas academic publishing is often intellectually inaccessible if not physically inaccessible, blogs expose the life of the scholar and help to make “scholarly work accessible and accountable to a readership outside the academy” (p. 148). Additionally, she stated that blogs help with brainstorming, especially for graduate students.

#### *Scientists' Use of ICTs*

Lamb and Davidson (2005) placed scientists' use of ICTs into three categories: embedded, coordination, and dissemination. Embedded ICTs are things such as sensors and analysis tools

which are part of the research work. Coordination ICTs connect scientists and allow for communication among them. Dissemination ICTs enable scientists to share data, papers, and knowledge with a broad audience. Blogs might serve as either coordination or dissemination ICTs.

There have been many studies in the past 15 years of how scientists use earlier ICTs such as e-mail, e-mail discussion lists, e-print servers, personal web pages, and instant messaging. Studies have emphasized the adoption of new technologies (Abels, Liebscher, & Denman, 1996; Kling & McKim, 2000); their uses for greater productivity (Hesse, Sproull, Kiesler, & Walsh, 1993; Walsh & Maloney, 2002); and disciplinary differences in usage of ICTs (Talja, Savolainen, & Maula, 2004; Walsh & Bayma, 1996). The use of personal web pages and discussion lists are pertinent as predecessors of blogs.

*Personal web pages.* The term “personal web page” means an internet page built and maintained by the scientist, his staff, or professional web developers working with the scientist to provide contact information and information about projects, courses, research, and publications. Döring’s (2002) systematic review of research on personal web pages describes the use of personal web pages to shape self-presentation: web page owners can design their sites carefully to create a desired impression in an unknown audience in ways that can not be done in face-to-face communication. The studies Döring reviewed found that owners of personal web pages “presume a very heterogeneous audience, which extends from their closest personal environment (friends, family) to acquaintances from the internet, colleagues from work and people with similar interests all the way to unknown random guests” (“For which audiences are personal home pages designed?”). The purposes for maintaining a personal web page include communication, network building, maintaining a list of links for quick access, and experimenting

with and learning web design (Döring, 2002). Scientists' personal web pages typically include contact information, research interests, courses taught, a curriculum vitae, and a list of publications (Lamb & Davidson, 2005).

Scientists' views and uses of personal web pages vary by discipline, experience level, and level of connectivity within peer networks. Lamb and Davidson (2005) found that senior researchers with established networks and publication records do not place a high value on personal web pages. Frequently, the pages are allowed to be out of date and are not enhanced with multimedia. The researchers also found that peripheral and younger scientists without extensive publication records have web pages that are more personalized, up to date, and detailed. Junior researchers use their personal web pages to build their professional identities and reputations and to attract funding and collaborators.

In contrast, Barjak (2006) found that highly productive researchers, typically those who frequently attend conferences, are more likely to maintain personal web pages than less productive researchers. He also found that senior researchers are more likely to have personal web pages, but he attributed this finding in part to the scientists' hierarchical status in their organizations. In other words, lab directors and project managers have personal web pages that are created or maintained by their organizations or support staff. (Barjak, 2006).

*Scientists' use of e-mail discussion lists.* Some features of e-mail discussion lists seem to be antecedents of scholarly weblogs. Indeed, the claims in some of the articles on blogs mirror claims in earlier articles that discussion lists would replace hallway conversations at conferences (Allen, 1991). In their infancy, e-mail lists were open to new participants and were envisioned as equalizers because of the relative anonymity of the new medium (Gresham, 1994).

In fact, study showed that discussion lists became places for one-to-many or few-to-many broadcast announcements instead of many-to-many conversations (Rojo & Ragsdale, 1997). Concerns about information overload have caused many scientists to abandon high-traffic lists (Talja et al., 2004). Frequently, scientists are members of only closed lists or project-related lists (Walsh & Bayma, 1996). A proliferation of blogs could create an even greater perception of information overload. It is impossible to determine if scientists' blogs will become nearly ubiquitous, like personal home pages, or will be abandoned, like many mailing lists.

### *Purposes*

In addition to the purposes found in general studies of blogs, three primary purposes of blog use are suggested by a consideration of the general nature of blogs, the uses of other ICTs by scientists, and the results of Amsen's 2006 survey of science blogs: for PIM, for informal scholarly communication, and for communicating science to the public.

*Personal information management.* PIM is the acquisition, organization, maintenance, and retrieval of personal information (Jones, 2007). Personal information is variously described as e-mails, calendars, web pages, books, articles, letters, scientific specimens, laboratory notebooks, and blackboards full of equations (Jones, 2007; Kaye et al., 2006). Some of the reported uses of blogs have been as research logs or diaries (Mortensen & Walker, 2002).

Depending on the practices of the scientific discipline, laboratory notebooks can function as diaries. Researchers maintain records of their work over time -- including meeting notes, experimental observations, and early analysis. Although disciplinary best practices and professional standards exist, each scientist uniquely interprets these practices to create an individual lab notebook process that serves his or her needs (Shankar, 2007). Electronic laboratory notebooks have not been well received because they force a rigid external structure on

the record-keeping process; yet some younger researchers or researchers with computer science backgrounds do keep web notebooks (Shankar, 2007).

*Informal scholarly communication.* Scholarly communication is the communication of scientific information to members of the invisible college; that is, to other researchers in the social circle who have similar training and background knowledge (Crane, 1972). In Garvey and Griffith's (1967, 1972) standard model for scholarly communication, such communication progresses from the earliest reports of data to local audiences through formal presentations in peer-reviewed journal articles. Over time, the communication becomes more polished and more abstract and loses immediacy, specificity, and thoroughness. Informal scholarly communication is the communication within the invisible college throughout the scholarly communication process. It includes informal discussions of results, keeping up on new work, and seeking potential collaboration partners. Typical communication channels for informal scholarly communication include e-mail, mailing lists, hallway conversations at conferences, sharing pre-prints through e-mail and on e-print servers, and maintenance of personal web pages (Kasperson, 1978, cited in Barjak, 2006; Kraut, Egidio, & Galegher, 1990).

*Communicating science to the public.* Communicating science to the public, or popularization of science, is defined by what it is not: it is not communication to a specialized expert scientific community (Myers, 2003). Popularization occurs over the course of the research and to many different audiences including funding organizations, scientists outside of the immediate research area, and non-scientists. Moreover, communication of science to the public is cyclical and bidirectional. Scientists learn and redirect their work upon engagement with the public (Myers, 2003).

The public audience for science communication is a stratified target. Miller (1986, cited in Kyvik, 2005) describes a pyramid with decision makers at the top; policy leaders at the next level; the attentive public, i.e., members of the public with some college-level training in science who closely follow science news beneath them; the interested public; and finally the non-attentive public. Because research is so specialized, everyone is a lay person outside of a particular field (Kalleberg, 2000, cited in Kyvik, 2005). The lay public encompasses those with little or no scientific training as well as scientists outside the particular research area. Indeed, scientists are consumers of popularizations of science, particularly in areas outside their specialties that they need to teach (Myers, 2003).

Researchers have found several reasons scientists communicate with the public. Dunwoody (1986, cited in Kyvik, 2005) found that scientists do so for personal satisfaction; public recognition; employer recognition; political recognition (including recognition by funding agencies); and peer recognition. The reasons not to communicate with the public might be more compelling: the research requires significant understanding of the research area or use of symbolic language for understanding, popular communication is not respected or considered in tenure or promotion decisions, and public communication might decrease the author's prestige in his or her own community.

Kyvik (2005) defined a civic scientist as "a scientist who communicates with general audiences and brings knowledge and expertise into the public arena to increase awareness about science and/or facilitate discussion and decision making on issues of importance to society" (p. 289). This definition suggests two roles scientists play in communicating to the public: expert and public intellectual. Experts have the role of dissemination of knowledge to lay persons and the goal of educating society, while public intellectuals have the role of political engagement and

the goal of influencing political, cultural, and social issues (Kyvik, 2005). An expert gains legitimacy through claims of expertise evidenced by institutional affiliation and publication in high-impact peer-reviewed journals (Myers, 2003).<sup>3</sup> A public intellectual gains legitimacy through academic credentials, recognition within and outside of his or her community, non-partisanship, and an independent voice (Brouwer & Squires, 2003).

#### *Summary of Literature Review and Foreshadowing Questions*

Nearly all scientists use the internet (Barjak, 2004), yet only a small percentage maintain blogs. Scholars from the humanities and social sciences who maintain blogs describe many gains; moreover, blogs have great potential to help scientists with PIM, informal scholarly communication, and public communication. Can blogs help scientists? How do blogging scientists perceive their value? This study seeks to explore how and why chemists and physicists use blogs. To understand this, we need to learn the purposes, intended audiences, perceived benefits to both the bloggers themselves and their communities. We also need to learn how the participants make meaning of other scientists' blogs.

#### Methods

Qualitative research methods were chosen for this study to achieve a richer understanding of the scientists' perceptions and processes of blogging and to explore the variety of scientists' experiences with blogs through in-depth analysis of the blogs and semi-structured interviews with the scientists. While there have been qualitative studies on blogs in general (e.g., Nardi et al., 2004) and surveys of blog awareness and use (Lenhart & Fox, 2006), we do not have enough information on how scientists use blogs to formulate a quantitative study that would produce results suitable for supporting scientists' work or informing system design.

Two qualitative methods were used for the study: a directed qualitative content analysis of blog posts and blog “about” pages and in-depth semi-structured interviews of scientist bloggers. This triangulation of methods and sources is a first step in ensuring the validity of the research (Guba & Lincoln, 1982). Content analysis was used to learn what purposes and intended audiences could be determined from the blogs themselves. In-depth interviews were used to learn about the participants’ processes, purposes, and intended audiences. This section describes data collection and analysis for each of the two parts of the study.

### *Content Analysis*

Qualitative content analysis is a systematic analysis of texts or images to answer the research questions through discovery, documentation, and understanding the communication of meaning and theoretical relationships found in the text (Altheide, 1987; Mayring, 2000; White & Marsh, 2006). In directed content analysis, the researcher employs an initial framework developed from previous research which is used to focus the study and develop foreshadowing questions (Hsieh & Shannon, 2005). The steps in directed qualitative content analysis include developing preliminary categories, developing a collection of cases, selecting a purposeful sample of cases, analyzing the cases using the preliminary categories, formulating inductive codes from the material, and interpreting and analyzing the results. These steps are not linear; rather, the researcher must continually compare the evidence with other evidence and the extant categories and must question and verify the coding (White & Marsh, 2006).

*Building the collection.* The first step in the content analysis for this study was to build a collection of scientists’ blogs from which to select a purposeful sample. A general collection of scientists’ blogs was developed by locating science blogs in directories and through links in blogrolls.<sup>4</sup> The blogs were visited to determine whether the author self-identifies as a scientist.

For the purposes of this study, only English-language blogs written by scientists were considered. Selected blogs were bookmarked and annotated with the scientific discipline of the author and the author's status as student, faculty, or researcher. Only blogs that had been updated within three months and that had more than ten posts were kept. Ultimately, 15 blogs were selected for in-depth analysis (see Appendix). This collection of blogs is a small part of the estimated 1,200 science blogs (Bonetta, 2007), but it covers the most active and heavily linked blogs.

*Extracting a purposeful sample.* A sample of blogs was selected from the collection described above to create information-rich cases. As a first step, only blogs written by chemists and physicists were selected because these scientists operate in well-characterized scholarly communication environments. While chemists publish mostly in well-controlled, expensive, closed-access, peer-reviewed journals and conference proceedings, physicists have been innovators in open access publishing through publication of pre-prints as well as publishing in traditional peer-reviewed journals and conference proceedings.

Within the collection of blogs by chemists and physicists, individual blogs were selected to represent the greatest heterogeneity in the author's setting, status, and research area (Maxwell, 2005). For example, selections included: professors in small liberal arts colleges as well as in large state research institutions, researchers in corporations, students as well as tenured professors, and theoreticians as well as experimentalists. Maximum-variation purposeful sampling is useful for "capturing themes that cut across a great deal of variation" (Patton, 2002, p. 235). Additional blogs were added during the course of the study to explain some variation. Sampling ceased when new blogs contributed no new codes or themes.

A screenshot of the home page of each blog was captured, and the contents of the “about” page (or first post for blogs without “about” pages) and each of the most recent ten entries including embedded images and non-text mark-up were copied into document files and imported into the qualitative data analysis software, NVivo7 (QSR International, 2007).

*Analysis.* The imported files were coded using the preliminary coding scheme developed through the literature review. The unit of analysis was the blog post or the paragraph (if multiple types of content were included in a post). New codes were inductively developed for emergent categories. The constant comparison method across posts and across sources was used to complete the coding. Questioning and looking for variations or counter examples was done to increase validity. Throughout the data collection and analysis process, memos, notes, and annotations were used to capture emerging themes and impressions and to create an audit trail.

Themes developed through this analysis were used to revise the preliminary interview guide and coding scheme and to select interview participants.

### *Interviews*

In-depth responsive interviews (Rubin & Rubin, 2005) were conducted with selected bloggers. The purpose of the interviews was to learn how the scientists perceive blogging, what value they receive from blogging, and how blogging fits into their research lives. The guide was tailored further for individual participants based on the content of their blog.

Participants were selected from among the authors of the blogs used in the content analysis. Selection considerations include achieving a variety of working environments; academic disciplines; working statuses (e.g., faculty, post-doctoral researchers, graduate students); and blogging experience. In total, six participants were interviewed. All interviews

were conducted via telephone and lasted from 25 minutes to 1 hour 15 minutes. The interviews were recorded and transcribed and the transcripts were loaded into NVIVO7 for analysis.

*Analysis.* The transcripts were analyzed in a fashion similar to the content analysis. The preliminary coding scheme was developed from the foreshadowing questions and the results of the content analysis. The transcripts were coded and new codes inductively developed for emergent categories.

Case summaries were created for each blogger to gather categories from the content analysis and interviews. While maximum variability sampling method was used to facilitate identification of cross-cutting themes, the case summaries were useful to explore the complexities of individual cases (Patton, 2002). Once case summaries were complete, cross-case comparisons were made and common themes were extracted. These themes were checked against the interview data and were elaborated, modified, combined, or split as appropriate.

## Results

The blogs studied varied from precisely targeted, high-level science to eclectic collections of personal, hobby, political, and scientific content. Two blogs, one maintained by a physicist and the other by a chemist, were almost exclusively expert commentary on new research articles. The remainder mixed all of the various types of blog posts. Some individual posts were aimed at graduate students or junior researchers and contained job hunting and tenure advice. There was no evidence that the blogs were being used as replacements for personal web pages and none of the blogs in the study contained reports of original research.

The participants in this study have diverse experiences with their blogs, but cross-case comparisons yielded some common themes: personal and private in a public sphere, blog-life

boundaries, social circles and the blog community, an interactive medium, a personal choice, filling a gap: a new form of scholarly communication, and a learning tool.

### *Personal and Private in a Public Sphere*

The blogs in this study are interesting combinations of personal thoughts, notes to friends, political speech, and scholarly communication. The bloggers negotiate the private-public mix through controlling their identities and developing clear policies for what content is appropriate to include on the blog.

The participants control their identities through their choices to be anonymous or pseudonymous; to provide only limited personal information, such as a first name; or to provide complete contact information and include links to professional web sites and curriculum vitae. Of the blogs used for content analysis, five of the bloggers do not use their full real names. Some bloggers' names are known or are easily discoverable, but others have kept their identities secret.

Bloggers who use their real names and provide professional contact information do so intentionally, after having made an explicit choice when starting to blog. One says with regret that he could be freer to blow off steam if he were anonymous, but the anonymous bloggers in this study do not seem to be any less concerned in content selection or more likely to engage in controversies. The participants were also skeptical that it is possible to remain anonymous if "sufficiently determined people" start digging.

Keeping his identity secret has been an ongoing struggle for one anonymous blogger. He decided to be pseudonymous to practice writing without receiving personal criticism and to keep the focus on the information, not himself:

I don't want people to focus on what I've done specifically but I want them to focus on the information and use the information for themselves and so I try to keep my own personal identification or identifiable stuff out of there.

He guards his anonymity by not mentioning the universities he attended or where he did his post-doctoral work. He also does not link to his company or mention it by name. However, an accidental naming of a building where he did graduate work yielded several e-mails guessing his alma mater. His audience apparently views his anonymity as a challenge rather than respecting his choice.

Another blogger provides only his first name; but his co-workers, his students, and the provost of his college are all aware of his blog and have commented on posts. A third blogger has chosen to use a pseudonym, but her choice has been respected.

The participants in this study developed detailed policies about how much personal information they will expose on their blogs:

One thing is that I try to keep a little bit of anonymity -- I'm not completely anonymous.

Somebody motivated could figure out who I am and where I work and things like that. So,

I do keep that in mind and try to minimize too much personal information.

Personal information about family life, children, and problems at work were mentioned as things that would not be posted.

### *Blog-Life Boundaries*

Bloggers tread the boundary between life and online life carefully. These two lives meet when bloggers select content for their blogs and when bloggers meet the readers of their blogs offline. The participants have developed policies for what they post on their blogs to protect relationships with family, colleagues, and friends. As mentioned above, bloggers protect the

privacy of their families by using nicknames for their spouses and children and by not talking about personal matters.

Situations that bring online and offline communities together can be awkward:

At conferences and so on they're opening will be "Hi ... I've been reading your blog." ... It's a little bit weird, it's a little weird because if it's someone that you haven't seen in a long time, there's this sort of asymmetry there, they know what you've been thinking about doing, what you've been up to...but you don't know what they've been up to.

Regular blog readers feel that they know an author through reading his writing over time, but the blog author knows very little about the audience. The participants review their server logs to determine how many visits their site has received, which sites link to their site, and which posts are viewed most frequently, but they have to rely on polls and feedback through comments to learn about their readers.

### *Social Circles and Blog Community*

Some of the participants know some of the commenters on their posts, the bloggers who write the blogs they read, and other readers of their blogs. However, in many cases bloggers form new online communities around their blogs and the blogs they read and these communities do not overlap with in-person communities:

I've found that people now know me by my pseudonym. They know the kinds of things that I've done and they know a little bit about me in the sense that they kind of know the area that I'm interested in and what my expertises are. And similarly I know what a lot of other peoples expertises are. And so it's nice because people with similar interests and

traits tend to gravitate toward similar blogs. And while I've never actually met anyone in person, I do have a sort of email rapport with a whole bunch of them

[blogger pseudonym] likes to post in my comments, and I like to post in his comments. I have no idea who he is... I tried at some point to set up, like I was going to go to one of these big national meetings and I was like, "Hey do you guys want to grab a beer I promise not to talk about who, not to divulge your identity." [But they were not attending the meeting]

As in other online communities the commenters and blog authors seem to have roles (Golder & Donath, 2004). There are many peripheral participants or *lurkers* – readers who do not comment or provide feedback – as well as *newbies* who are uncertain how to leave feedback. Participants in this study are occasional lurkers on other blogs: "I'd also been reading the general blogs ... and I didn't really want to comment on them" and "I try not to comment unless it's going to be useful." The participants also find that there are many more readers of their posts than there are commenters.

The physicist blogs in this study attracted many *flamers* and *trolls* in their comments. According to Golder and Donath (2004), a flamer's "behavioral strategy is intimidation through very aggressive language, yelling and controversial speech" (p. 16). One physicist has a commenter who "routinely posts very thinly veiled racist stuff." Another has commenters who "really seem to get some sort of great joy about using their anonymity to be obnoxious jerks ... they say things that are clearly designed to get a rise out of people."

Trolls superficially seem to start conversations but are really baiting community members to start arguments (Golder & Donath, 2004). Several of the blogs included in the content analysis

included comments from trolls who make repeated comments that seem to purposefully ignore or misunderstand previous comments or the original post.

### *Blogging as in Interactive Medium*

Blogs are defined as a format: a collection of posts in a certain order. It may seem, then, that blogs are a broadcast medium; that is, that they constitute one-to-many communication. However, this study shows that the bloggers form communities. Also, the participants in this study engage with their readers, select content and develop posts based on reader feedback, and ask for help from their readers:

I find that my blog is a great way to get an answer to my question really, really quickly ...Because I manage the blog, I know how to find the answer very very quickly so it's a wonderful selfish way to get what I want very quickly.

The help might be in getting a copy of an article not available locally: "I have limited access to scientific journals and so I've had a couple of people send me some journal articles on things that I was wondering about on my blog."

The requested help also might be in figuring out some detail in an article:

*(Sometimes I ask questions that I don't know the answer to. This is one of those times.)...*

So, how is it that a ligand can 1) bind to an active site and stay there, I would think that it would take too much energy to "hold" the wobbling active site together, considering the ambient thermal motion and 2) possibly induce a conformational change...Am I missing something huge here?

More than one participant mentioned specifically asking for help when designing a new class. They ask for textbook suggestions, areas to cover, demonstrations that are useful, and the best way to explain complicated topics:

“Hey, I’m going to teach about, I need to teach a class about this. What do you think are the most important things to know about this sub-topic?” And I post that and people leave comments, “This is the thing that,” “This is the really critical thing,” “Make sure that you tell them this.” Or I’ll say, “Hey I’m going to explain this, I need a good analogy for this odd effect, what would be a good analogy?” And I’ve gotten some really useful suggestions, or suggestions of things to demonstrate.

The participants also modify their blogs based on reader feedback. For example, one participant was told that it was not useful to post only a link and an abstract of an article and that he needed to post substantive analysis for the posts to be useful. In response, he only posts thoughtful commentaries or new research ideas.

The author’s initial intended audience is often quite different from the actual audience; accordingly, several participants mentioned blogging about topics that were relevant to the readers who commented or sent e-mail:

I quickly realized that the average person doesn’t look for chemistry-related blogs, so I very quickly changed my tone of writing to be more towards graduate students...After the first couple of weeks it’s very apparent that I had a target audience that was a graduate population

#### *A personal choice*

Even though the bloggers are attuned to audience feedback, they stress that maintaining a blog is a personal choice. A person has to get in the habit of posting (one participant compared it to flossing) and has to perceive value in the act of blogging. Some of the participants have tried to convince others to blog, have let others guest post, and have set up blogs for colleagues but

blogging is something people have to decide to do for themselves. As one participant stated, “It seems to be that either you have an inclination or you don’t.”

Part of the personal choice is choosing not to post content for the sole purpose of boosting readership. For example, high-energy physicists posting about string theory in a certain way contribute to what one participant calls “the string wars.” These posts get many more page views and comments but can change the tone of the blog in a negative way:

I also try to avoid certain topics that I know cause trouble. I’ll talk about politics but there are some areas of politics that are just more hassle than they’re worth...I have posted about that in the past and it just, it wound up being a huge nightmare... that’s not what I’m trying to do.

Likewise, a chemist blogger does not post about what corporations are doing and posts only scientific information about government regulations instead of political speech:

At the moment [my blog is] not being brought to many people’s attention and I’m quite happy with it that way, having a small audience rather than being controversial.

This view is quite different from some popular assessments of blogs as political activism (cf. Cohen, 2006) and from some of the research on the uses of blogs in general.

*Filling a gap: a new form of scholarly communication*

The participants don’t view blogging as simply moving another form of communication to a new medium but as a *new* form of scholarly communication that fills a gap:

It occurred to me that this might be a really interesting communications medium, and I wanted to do things in terms of scientific communications that one couldn’t do before... [ArXiv.org] didn’t change the format, just the distribution medium. So, I was really actually thinking about changing the format... there were sorts of scientific

communications that didn't quite fit into the conventional paper article, and the web had an interesting way of distributing those sort of communications. And so here was a way to possibly do that.

The participants do not post information about their research in progress that might eventually be published in a paper due to concerns about journals' rules in regard to prior publication. Likewise, their blogging does not take the place of scientific meetings or conferences. For theorists, blogging is a way to respond to reading a paper, when there is not enough new to merit a research paper:

I had to make the decision as to whether some particular idea that I had merited a blog post or a paper... For me, it's an either-or thing.

It might also be a way to fill in details for papers that are shortened to meet the publication guidelines of particular journals:

One occasion where I have actually written stuff on my blog to do with a paper that I had recently written was one where my collaborators insisted on putting the paper in *Phys Rev Letters*, which has a four page limit. Ok. I felt that the prose that ended up in the paper was unintelligible, even to the author, and so I ended up, you know, writing some stuff on my blog about it because I felt it merited further explication.

Experimentalists blog about the process of their work or about issues they have with completing their experiments, but rarely the results of their experiments:

When I talk about my own research, I talk about, sometimes I talk about the science, but sometimes I talk more about the process.

*A learning tool*

One way the blogs have replaced previous technologies is in their use as a notebook to jot down ideas, critiques, and calculations while reading research papers. The blogs become a learning tool.

The participants frequently use their blogs to comment on published research. They spend a great deal of time preparing their posts prior to adding them to their blogs. They carefully read articles and check facts:

If I'm going to put something on my blog, it takes a fair amount of effort for me to make sure that what I put on there is accurate and so I know as much about it as possible. And so as a result it's forced me to learn more things, learn as much as I can, and improve my base of knowledge in those regards. And as far as interacting with other colleagues, there are always interesting comments that I get on various topics make me think, "Oh, I never thought of that," or, you know, realize that I was wrong about something or inaccurate. So it's really a learning experience for me.

Several participants reported learning through writing -- both about writing, and about the subjects they were reporting. Putting notes on a blog instead of in a paper notebook allows members of the community to learn from the article and to post clarifications if the author misunderstood or misrepresented some part of the research.

I read papers, have random thoughts on various topics, back in the old days I would write them down in a notebook and then subsequently, a year later, be unable to find it. Whereas it's definitely findable on my blog so it, it's actually very helpful.

The blogs act as a learning tool as well as a tool for personal information management. Two participants post lists of links of interest, and then can re-find information through their blog.

## Discussion

The participants' explicit purposes for maintaining blogs included blowing off steam, practicing writing in an informal setting, to communicate science to the public, to write about what life is like as a scientist, to reach a larger audience, to point out interesting papers, for fun, to provide a forum to support younger scientists, and to stay in touch with friends and family. Some of these purposes are unexpected given the literature on scientists' information and communication behavior.

Articles on scientists' views towards public communication of science sometimes indicate that scientists are unwilling to communicate with the public. In this study, some of the participants started their blogs specifically to popularize their work and other work in their field as expert commentators (Kyvik, 2005). Unfortunately, the public did not come. The participants found that their audiences were generally other scientists or well-educated people with a strong interest in science.

While some of the participants do blog about politics and controversial issues, the majority of the blogs in this study did not. Instead of using their blogs as public intellectuals (Brouwer & Squires, 2003), the participants form and join informal communities that provide support and friendship. Mentoring younger scientists through their blogs is important to the participants. Although blogs and blog content have the potential to be useful for identification of potential collaboration partners, only one participant reported a new research collaboration resulting from his blog.

These blog communities do not function as invisible colleges in an important way: the participants will not post data or reports of completed work to their blogs if they believe the work is publishable. This is not due to concerns of being scooped, but concerns about journals'

prior publication rules. In physics, the established pre-print servers *are* safe prior to acceptance in a journal because the physics community has negotiated their role. Individual blogs are not seen as an appropriate venue for posting of pre-prints, but are frequently used to post information that is too little or too much for a journal article. In this way, they fill a gap and are a new form of scholarly communication instead of another channel to communicate publishable research.

The participants in the study read between five and fifty blogs on a regular basis. They use these blogs to keep up in diverse research areas and to learn about science policy issues. There are not enough blogs to act as a substitute for journals or conferences, but some blogs post reviews of articles that are just as thorough as some found in traditional publications but are more timely. For example, the chemists particularly value a blog maintained by a British doctoral student that contains detailed reviews of new articles in organic synthesis.

In their reading selections, the participants differentiate between “hardcore” science blogs and “sociological” science blogs. Sociological science blogs are those that discuss policy and political issues related to science. But, it is not really the approach that attracts the participants as readers. Rather, they select blogs primarily because of the personality of the blogger and the quality of the writing.

### Conclusion

This study examined how and why a small sample of chemists and physicists blog. Two qualitative methods were used: Qualitative content analysis of blog posts and “about” pages and responsive interviews. The data were analyzed using the constant comparison method and several themes emerged: personal and private in a public sphere, blog-life boundaries, social circles and the blog community, blogging as an interactive medium, a personal choice, filling a

gap: a new form of scholarly communication, and a learning tool. Although this was a small study, the results provide valuable insights into how scientists use blogs.

### *Limitations*

The blogs and bloggers selected for the study were easily found, provided contact information, and agreed to participate. Many science bloggers, in particular female science bloggers, do not provide contact information on their blog and carefully guard their anonymity. These bloggers may have very different blogging experiences that are not represented in this study. Future studies should address experiences of anonymous bloggers.

### *Implications*

The participants in this study clearly benefit from maintaining blogs; however, they see these blogs as personal spaces. Any institutional support for blogging must respect blog-life boundaries. Organizations employing scientists should make blogging software available, as well as support the work of programmers to customize the tools to enable posting of scientific information. More than one participant spent a great deal of time programming to be able to display equations or chemical structures.

Tools are also needed to connect scientists, teachers, and parents to science blogs. Professional societies should consider compiling members' science posts as a service to their members. Likewise, outreach staff and informal science educators should consider linking to science blogs in their communications. Science bloggers might appreciate public communication training if available through workshops at conferences or articles in membership publications.

### *Future Work*

This study focused on chemists and physicists. Additional studies of life scientists, earth and planetary scientists, computer scientists, and mathematicians would yield a broader view of

how scientists use blogs. A follow-up study using quantitative content analysis and surveys would show the prevalence of the uses and benefits found in this study. A survey that asked demographic questions could explore potential correlations of the blog uses and experiences to characteristics of the blogger such as work setting, work status, and discipline.

Specifically excluded from this study were members of the attentive public who blog about science but are not practicing scientists such as philosophy of science professors, science communication professors, and science journalists. A follow up study could look at how this group popularizes science or the genres they use to discuss science.

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## Appendix

## Blogs used for content analysis

Participants requested that their blogs be credited in the final report.

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Footnotes

<sup>1</sup> Blogs are an interactive communication technology; therefore, their rate of adoption depends on network effects, such as critical mass, as well as features of the technology, such as relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003).

<sup>2</sup> Retrieved March 21, 2007 from <http://www.interactions.org/quantumdiaries/>

<sup>3</sup> Myers (2003) also describes gaining expertise through connection with the public's lived experience but notes that, although this is effective, it is less common.

<sup>4</sup> A blogroll is a list of links to other blogs of interest to the author(s).