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What Science Communication Scholars Think About Training Scientists to Communicate

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Abstract

The current study involved an attempted census of first and second authors from five key journals across the subfields of science, health, environment, and risk communication between 2003 and 2008. Of those responding ($n = 320$), 80% describe themselves as a communication expert. Of these experts ($n = 255$), 57% report conducting formal training for bench scientists and engineers, science regulators, medical personnel, or journalists. The main focus of training was in basic communication theories and models. There is broad agreement that the science community would benefit from additional science communication training and that deficit model thinking remains prevalent.

Keywords

training, deficit model, deliberation, public engagement, survey

The public experiences science through news and entertainment media and through interaction with science communicators. Most commonly, science is channeled to the public through newspapers, magazines, television, and the Internet (Nelkin, 1996a, 1996b; Project for Excellence in Journalism, 2009).

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According to the Pew Internet and American Life Project (2006), television and the Internet are the most popular sources for science news and information. Eighty-seven percent of online users say they have used the Internet to research a scientific topic (Horrigan, 2006) and 80% have searched online for health information (Fox, 2008). However, the public can also interact with science through museums, science cafes, deliberative forums, and outreach by a host of academic and community-based organizations. Such programs have grown significantly in size and number over the past decade (Crockett, 1997; McComas, Arvai, & Besley, 2008). More traditional forms of engagement, such as public meetings or hearings on health and environmental issues, may also bring citizens into contact with science communicators (Beierle & Cayford, 2002; McComas, 2001).

As an increasing amount of science news and information becomes available to the public through the mass media and other less mediated sources, interaction among scientists, the media, and the public is becoming commonplace. An international survey of biomedical researchers found that 70% of respondents had interacted with the media in the past 3 years (Peters et al., 2008a, 2008b). A 2006 study of research scientists and engineers found that nearly three quarters (74%) reported taking part in at least one science communication or public engagement activity over the past year. The same study also found that scientists with previous communication training are more likely to participate in public engagement (Royal Society, 2006).

Such science communication training is increasingly being offered to working scientists and undergraduate and graduate students (Basken, 2009; Turney, 1994). Typically, this type of communication training consists of activities—including courses, workshops, and/or seminars—designed to prepare scientists to interact with the media and teach them to speak more often and more clearly to the public and to policy makers (Basken, 2009; Peters et al., 2008a, 2008b). In some instances, these science communication workshops may also educate professional journalists on specific scientific issues or methods.

Despite efforts to improve the science-media-public relationship by training scientists to interact with the media and the public, no studies have yet examined the communication training taking place from the perspective of the science communication experts. Steve Miller (2008) contends that there is a perception that science communication practitioners are disconnected from the relevant literature in the field. He also concludes, however, that there seems to be little, if any, solid research examining whether or not this perception stands up to investigation (S. Miller, 2003, 2008). The current study seeks to address this gap in the literature through a census of a broad population of science communication scholars. The goal is to speak in a generalizable way about the state of science communication training and views about the skills of several different types of science communicators. The current study does not specifically test theory in the areas of media effects or public engagement, but rather seeks to assess the volume and scope of the training taking place and explore the topic from the viewpoint of the science communication scholar. However, the nature of the questions touches on several areas of previous research, including work that has explored the relationship between scientists and the media as well as the long-standing concern by science communicators about the prevalence of "deficit model" thinking—the belief that increasing the public's knowledge about science will lead to greater enthusiasm for science and technology.

Scientists and the Media

There have been numerous examinations of the somewhat tumultuous relationship between scientists and the media. For example, studies show that science and health experts believe information reported in the media is often unclear or inaccurate (Hoffman-Goetz, Shannon, & Clarke, 2003; Yeaton, Smith, & Rogers, 1990) and that such inaccuracies often occur because journalists lack the training to cover scientific issues or reports are too brief to grasp the significance of the story (Moyer, Greener,Beauvais, & Salovey, 1995; Tanner, 2004). This work is reflective of several qualitative studies, many with European roots, which explore scientists' views of media and the public. These studies almost universally portray scientists as blaming journalism for perceived public inadequacies (Blok, Jensen, & Kaltoft, 2008; Burchell, 2007; Burningham, Barnett, Carr, Clift, & Wehrmeyer, 2007; De Boer, McCarthy, Brennan, Kelly, & Ritson, 2005; Krystallis et al., 2007; Young & Matthews, 2007). Blok et al. (2008) call this perspective scientists' "Dominant Model" of how public opinion about science is formed.

In contrast, journalists contend that scientists lack a basic understanding of the journalistic process and the communication skills needed to relay information to the public (Nelkin, 1996a; Tanner, 2004; Willems, 2003). This literature has been summarized by several authors (e.g., Allan, 2009; Dunwoody, 1999; Stocking, 1999). There is also a growing body of literature indicating that stories in the popular press primarily focus on the benefits of science and technology (Caulfield, 2004, 2005; Nelkin, 1996a; Nisbet & Lewenstein, 2002; Tanner, 2004; Willems, 2003). Caulfield (2005) refers to this process as a "cycle of hype," in which social forces create a positive spin on representations of biotechnology that minimizes risks and limitations.

Such forces include pressure to "sell" research in exciting terms (Davidson, 2000), press releases that exaggerate the importance of study findings, and a bias toward positive findings in peer-reviewed papers that report industry-supported research (Woloshin & Schwartz, 2002). The media, dependent on researchers and their institutions for newsworthy information (Donohue, Tichenor, & Olien, 1995), transmit these enthusiastic scientific findings to the public.

The interactions among scientists, media, and the public recently gained prominence in the popular press through a study by the Pew Research Center for the People and the Press in collaboration with the American Association for the Advancement of Science. The study, titled "Public Praises Science; Scientists Fault Public, Media," surveyed several thousand American Association for the Advancement of Science members and the general public and found that 49% of scientists believe media over simplification was a "major problem" for "science in general." In addition, 76% of scientists said the inability of news reports to distinguish between good and bad science was a "major problem" (Pew Research Center for the People and the Press, 2009). A study by the Royal Society in the United Kingdom focusing on engagement activities by scientists found that some 37% of respondents indicated that they found some element of the media "hardest to talk with" about their research findings (Royal Society, 2006).

Within academia, however, recent studies challenge the perceived conflict between scientists and the media. Dunwoody, Brossard, and Dudo (2009) found that the relationship between scientists and the media is increasingly positive as scientists learn to interact efficiently with the media. A 2008 survey of scientists in top research and development countries had similar results, finding that the interactions between scientists and the media are more frequent and more positive than previously thought (Dunwoody et al., 2009; Peters et al., 2008a, 2008b). Using a case study approach, one study found that scientists participating in science communication workshops found the training beneficial, indicating that the sessions had provided them with useful skills that would help them discuss science with the general public (S. Miller, Fahy, & Team, 2009).

As a response to scientists' concerns that they are being misrepresented as well as concerns that scientists fail to provide potentially useful guidance on policy debates, several scholars have called on scientists to improve their ability to communicate with the public through both the media and direct engagement (Bubela et al., 2009; Nisbet & Mooney, 2007; Nisbet & Scheufele, 2007). A primary goal of the current study is to assess if science communication scholars believe that groups within the science community, including scientists and engineers, science regulators, and medical and health personnel, would benefit from enhancing their communication skills. For comparison purposes, science journalist training and views about scientists are also considered in the context of the work by Peters et al. (2008a, 2008b). Furthermore, several different areas of communication training, including both media and nonmedia components, are considered.

Research Question 1: How much training are science communication scholars conducting for the science community, including science journalists, and what is the focus of this training?
Research Question 2: Do science communication scholars think members of the science community would benefit from additional communication training?
Research Question 3: In comparison to scientists, how do science communication scholars view the state of science journalism?

Deficit Model Thinking and the Role of the Public

Deficit model thinking is the belief that public skepticism toward modern science is caused by a lack of adequate knowledge about science. Furthermore, this skepticism, or "knowledge deficit," can be overcome by providing sufficient information to the public. While it is clearly true that the public has relatively low levels of scientific knowledge as measured by standard survey instruments (for reviews, see Bauer, 2008; J. D. Miller, 1998; Sturgis & Allum, 2004), science communication scholars have often lamented that literacy is not particularly predictive of views about most scientific topics (for a review of this discussion, see Bauer, Allum, & Miller, 2007). The research cited above regarding scientists' concerns about the media's impact on public ignorance often includes mention of such deficit model thinking, and some survey research has specifically focused on the prevalence of deficit model thinking in scientists (Frewer et al., 2003).

One alternative to deficit model thinking is, of course, a contextual approach that gives a place for nonexperts in science discussions (e.g., Wynne, 1992). In practice, the result of this critique has been the emergence (for a discussion of this history, see Irwin, 2008) of models of science-based public engagement that often draws on political theory associated with deliberative democracy (Elster, 1998; Gastil & Levine, 2005). This engagement-focused approach to science communication underlies the rationale and design of both informal science communication activities as well as more formalized attempts to get upstream input from the public on emerging issues (for reviews, see Einsiedel & Eastlick, 2000; Joss & Belluci, 2002; McComas et al., 2008).

The current study explores the issue of deficit model thinking by asking science communication experts the degree to which they believe those involved in science exhibit such views, including their perception of what scientists think is an appropriate role for the public in scientific debates.

> *Research Question 4:* According to science communication scholars, how prevalent is deficit model thinking within science communities?

Finally, in order to better understand science communication scholars' responses, we also looked for patterns in responses based on contextual factors such as years of professional experience, time since terminal degree, subfield identification, gender, and research productivity.

> *Research Question 5:* Are there any meaningful relationships among training, experience, perceptions of the science community's views, and contextual variables?

Method

Sampling

No standard list of science communication experts, broadly defined in this study as experts in the fields of science, health, environment, and risk communication, exists. The authors therefore began by compiling a list of first and second authors who had published research for the years 2003-2008 in the key Web of Science indexed academic journals focusing on science, health, and/or risk communication. These journals included the *Journal of Health Communication*, *Health Communication*, *Science Communication*, *Public Understanding of Science*, and *Risk Analysis*.[1] Not only has a similar sampling procedure been used in previous science communication studies (Besley et al., 2008; Peters et al., 2008a, 2008b), this sampling strategy seemed the most appropriate method to gain access to science communication experts across the subdisciplines of science, health, environment, and risk communication while yielding the relevant contact information needed to facilitate the survey distribution process.

The names of 964 science communication experts were obtained from these journals. In many instances, the authors' corresponding university and e-mail address were also listed within the text of the articles. If an author's contact information was not available, a Web-based search was performed to obtain the author's e-mail address.[2] Ultimately, 671 authors with corresponding e-mail addresses were collected and included in the sample frame.

In March 2009, an e-mail was sent to each science communication expert requesting his or her participation in a Web-based survey. A link to the online questionnaire was included in the e-mail.[3] Three follow-up e-mails, spaced approximately 1 week apart, were also sent in an effort to obtain a high-level of response. After nonworking e-mail addresses were purged from the list (n = 76), the revised sample frame included 595 names. Ultimately, 320 (54% of working addresses) respondents participated in the survey and fully completed the online questionnaire.

Measurement

To start the survey, respondents received a definition of "science communication," which described the subfield as any communication activity regarding science, health, environment, and/or risk communication. Also defined was the term *training*, which for the purposes of this study, included educational activities beyond regular teaching of undergraduate, graduate, or postdoctoral students but did *not* include indirect communication education or advice to clients, boards, or other collaborators. Respondents were then asked if they considered themselves an expert in science communication. If the respondent did not consider himself or herself a science communication expert, they automatically "skipped" to the end of the survey instrument to answer demographic questions. If respondents said they were an expert in science communication, they continued on with the survey. Eighty percent of respondents (n = 255) indicated that they considered themselves science communication experts. Most of the results below are based on these responses. Where the sample is less than 255, it indicates that not all respondents answered the question. In most cases this was because it was not relevant to the respondent and the surveys automatically omitted the question, but in other cases the respondent may have forgotten to answer or chosen not to answer.

In line with our research questions, the survey instrument measured the volume and scope of communication and media training activities conducted by science communication experts and how these experts view the communication skills of science journalists, bench scientists and engineers, science regulators, and medical/health personnel. Respondents first identified how much time over the past 3 years they had spent conducting science communication training to the various constituents and the focus of that training (i.e., being interviewed by the media, understanding new values, engaging citizens in dialogue/debate, media writing, and training in communication theories). Regarding training focus, a 5-point scale was used for each variable, ranging from 1 (*not a training focus*) to 5 (*sole focus of training*).

Next, a battery of questions ascertained how communication experts view the communications skills of bench scientists and engineers, science regulators, and medical/health personnel. Using a 5-point scale ranging from −2 = *strongly disagree* to 2 = *strongly agree*, science communication scholars were asked, for example, if most scientists (a) would benefit from media training, (b) believe the public have important views about science, and (c) believe that scientists are out of touch with what the public thinks when it comes to science. Questions from previous research (Peters et al., 2008b) were used to assess scholars' views about how the media covers scientific topics. The responses from this previous work, which focused on stem cell and epidemiological researchers, were compared with science communication scholars.

Several contextual variables were assessed for Research Question 5. To measure experience, the survey asked about expert respondents' years of professional experience using 7-category response scale with 1 representing 0 years of experience and 7 representing 16 years or more. To facilitate analysis, this variable was subsequently transformed into a continuous variable using the midpoint of each category and "18" for the final category (M = 4.44, SD = 4.19, n = 252). We also asked the year in which the respondent received their most recent degree and created a variable that measured years since earning that degree (M = 13.85, SD = 10.26, n = 251).

Another variable of interest was self-identification as a specialist in science communication (33% of expert respondents), health communication (67% of expert respondents), or risk communication (33% of expert respondents). These variables were assessed to give the degree to which training and views are occurring across subfields.

Our three final contextual variables were gender, number of published papers per year, and whether the respondent indicated they had received funding for training from one of several sources. Of those experts who conducted formal training (n = 147), 28% did so without any funding, 7% received National Science Foundation (NSF) training funding, 18% received National Institutes of Health (NIH) training funding, 12% received non-NSF/non-NIH federal training funding, 16% received state-level training funding, 5% received corporate funding, 25% received nonprofit funding, and 34% received internal corporate funding.

Analysis

As exploratory research, the analyses below rely mainly on frequency data (Research Questions 1, 2, 3, and 4) along with simple correlations to look at contextual relationships (Research Question 5). Correlations were used to investigate relationships between training of a group and views about that group as well as contextual variables. Correlations between the training of one group and views about other groups were not analyzed. Unless noted, the sample size for most correlations was between 245 and 255, depending on the number of respondents who chose not to the answer a question.

Visual inspection of the plots for relationships between several of the variables suggested curvilinear relationships, so quadratic terms (i.e., number of papers squared rather than number of papers) for the nondichotomous contextual variables are reported when those relationships were stronger than the equivalent linear relationships.

We did not report scores from statistical tests because the nature of the data—an attempted census of a specific population of scholars—makes sampling-based statistical tests meaningless. The error associated with the current study represents measurement, nonresponse, and sample frame error rather than sampling error. The article focuses instead on exploring what appear to be substantive relationships or differences between measurements. If treated as a sample, however, all the relationships reported would be significant at the $p < .05$ or lower.

Results

The 255 respondents who responded to our questionnaire and considered themselves science communication experts reported a broad range of training activities. Results related to Research Question 1 (Table 1) indicate that about one fifth of respondents trained bench scientists and engineers, and slightly less than a quarter reported training science or health regulators and/or journalists. Almost two fifths reported training health or medical personal.

Overall, if these numbers are combined, a total 57% of respondents indicated that, in an average year, they conduct formal communication training in some capacity. While 43% reported doing no formal training, 27% reported conducting less than 2 weeks, 7% reported conducting at least 2 weeks but less than 3 weeks, 4% reported conducting at least 3 weeks but less than 4 weeks, and about 20% reported 4 or more weeks of training. In addition to formal training, two thirds of respondents indicated they had taken part in informal

Table 1. Average Amount of Time per Year Devoted to Training Various Groups Over the Last 3 Years

	No Time	<1 Week/ Year	1 Week/ Year	2 Weeks/ Year	3 Weeks/ Year	>3 Weeks/ Year	*N*
Bench scientists or engineers	83%	8%	3%	2%	1%	4%	255
Science/health regulators	72%	12%	5%	3%	2%	6%	254
Medical/health personnel	63%	19%	5%	4%	2%	8%	254
Journalists/ communication professionals	73%	13%	3%	2%	2%	8%	254
Informal training	32%	31%	10%	8%	5%	13%	249

training related to science communication through involvement in review panels or on organizational boards. More than a third of respondents indicated that they conducted a week or more of informal training. Looked at another way, 25% of science communication scholars conducted training of just one of the four groups we considered, 15% conducted training of two of the groups, and 13% conducted training of the three of the groups. Only 4% (11 people) reported training all groups in the past 3 years.

The most common focus of training was in the area of basic communication theories and models. More than half of respondents indicated that training in communication theories and models was the primary or sole focus of training the three groups within the science community. On the opposite side, media training was the most likely to be listed as "not a focus" for all groups. As illustrated in Table 2, however, the training emphases differed by the type of group being trained. For example, training focused on public engagement and news values were relatively common for the bench scientists and engineers and science and health regulators while the medical health personnel appeared to receive some training on news values but very little in the area of public engagement. For journalists, the primary focus of training appeared to be in the area of understanding scientific topics and processes.

Regarding Research Question 2 (Table 3), science scholars are largely in agreement that bench scientists and engineers as well as science and health regulators would benefit from both media training and training in communicating with the public. There was somewhat less agreement on the whether medical and health personnel would benefit from media training, though there was agreement that such personnel would be benefit from training to

Table 2. Training Focus for Those Who Indicated They Conducted Training of Specific Groups

	Not a Focus (1)	Minor Focus	Secondary Focus	Primary Focus	Sole Focus (5)	*n*
Bench scientists or engineers (total *n* = 45)[a]						
Being interviewed by media	35%	33%	9%	21%	2%	43
News values/norms	20%	33%	20%	28%	0%	40
Public speaking/presentations	30%	27%	14%	27%	2%	44
Writing for public/media	24%	31%	24%	21%	0%	42
Communication theories/ models	21%	19%	5%	48%	7%	42
Engagement	19%	31%	21%	26%	2%	42
Science/health regulators (total *n* = 72)[a]						
Being interviewed by media	54%	19%	3%	22%	2%	68
News values/norms	28%	20%	20%	31%	0%	64
Public speaking/presentations	41%	24%	15%	18%	2%	66
Writing for public/media	41%	23%	15%	20%	2%	66
Communication theories/ models	19%	8%	16%	52%	6%	64
Engagement	31%	17%	20%	29%	3%	65
Medical/health personnel (total *n* = 95)[a]						
Being interviewed by media	64%	20%	1%	14%	1%	87
News values/norms	41%	24%	9%	22%	3%	87
Public speaking/presentations	45%	26%	14%	14%	1%	86
Writing for public/media	46%	24%	13%	18%	0%	85
Communication theories/ models	16%	13%	20%	44%	8%	87
Engagement	43%	23%	18%	15%	1%	83
Journalists/communication professionals (total *n* = 69)						
General science writing	38%	16%	13%	30%	3%	69
Understanding science topics	18%	21%	21%	35%	6%	68
Understanding science process	22%	16%	19%	37%	6%	68
Interviewing scientists	55%	21%	16%	6%	1.5%	67

a. Total *n* is lower than the *n* in any specific column because some respondents chose to enter an "other" category but did not indicate whether the other potential areas of training were covered. These were left as system missing rather than recoding them as "not a focus."

Table 3. Views About the Potential Benefits From Training and Perceptions the Lay Public

	Bench Scientists or Engineers			Science/Health Regulators			Medical/Health Personnel		
	Mean[a]	*SD*	*n*	Mean[a]	*SD*	*n*	Mean[a]	*SD*	*n*
Research Question 2: Potential for benefits from additional training									
Most _____ would benefit from media training (e.g., conducting interviews with journalists and/or learning news values/norms).	1.11	0.83	255	1.13	0.79	252	0.83	0.95	250
Most _____ would benefit from training to help them communicate directly with the public (not media training).	1.24	0.76	254	1.25	0.77	251	1.28	0.78	250
Research Question 4: Perceived prevalence of deficit model thinking									
Most _____ think if people knew more about science, the public would have different opinions on scientific issues.	1.16	0.75	251	0.68	0.79	251	0.62	0.82	248
Most _____ believe the public have important views about science that deserve consideration.	–0.27	0.92	253	0.12	0.88	250	–0.04	0.89	248
Most _____ are out of touch with what the public thinks when it comes to science.	0.35	0.90	253	0.10	0.84	249	0.20	0.87	246

a. –2 = Strongly disagree, –1 = Disagree, 0 = Neutral, 1 = Agree, 2 = Strongly agree.

communicate with the public. The average *r* between the six *benefit* variables was .55 (as noted, because this was an attempted census, no *p* value is reported) suggesting widespread belief in the value of training.

When asked about their views on media coverage of scientific topics (Research Question 3), as illustrated in Table 4, it appears that science communication researchers were mixed on the question of the accuracy of science reporting but more negative when it came to questions of source credibility

Table 4. Views About Science Journalism by Science Communication Scholars and Scientists

	Science Communication Scholars' Views			Peters et al. (2008) Scientists Views		
	Mean[a]	*SD*	*n*	Range of means for 4 countries[a,b]	*SD*[c]	*N*
Thinking of the mass media such as newspapers, radio, and television, please indicates your agreement or disagreement with the following statements. Media coverage of scientific topics in general, usually . . .						
is inaccurate	–0.06	0.98	251	–0.23 to 0.34	—	1,354
uses credible sources	–0.33	0.87	251	–0.23 to 0.47	—	1,354
is hostile to science	–0.70	0.77	250	–0.91 to –0.27	—	1,354
is sufficiently comprehensive	–0.79	0.96	251	–0.71 to 0.08	—	1,354

a. –2 = Strongly disagree, –1 = Disagree, 0 = Neutral, 1 = Agree, 2 = Strongly Agree.
b. Countries were France, Germany, Japan, the United Kingdom, and the United States of America.
c. Neither standard deviation nor standard errors were provided.

and comprehensiveness. There appeared to be agreement that the media is not hostile to science. In comparison with scientists (Peters et al., 2008b), science communication scholars are within the range of the scientists surveyed across four countries on the question of accuracy and hostility, but outside of the range on questions regarding the credibility of sources and on comprehensiveness. On these questions, science communication scholars were actually slightly more critical of the media than scientists.

As shown in Table 3, when examining deficit model thinking among science communication scholars (Research Question 4), respondents said they believed all groups subscribed to the idea that, if the public knew more, they would have different opinions about scientific issues (average r for all groups = .41). The communication scholars were mixed about whether they believe members of the science community think the public have important views about science that deserve consideration (average r for all groups = .46) or are out of touch with the public (average r for all groups = .42).

For Research Question 5, while there were a number of potentially meaningful relationships present in the data, the sizes of these relationships were generally small (Cohen, Cohen, West, & Aiken, 2003).

Relationships Between Training Time and Views About Trainees

The amount of time science communication scholars spent training scientists and engineers was not associated with different views about the potential benefits of communication training. However, there appeared to be a small relationship between regulator training and views about both the benefits of regulator media training (r = .18) and training for communication with the public (r = .17). The only other apparent pattern in the relationship between formal training and views about members of the science community was a small positive relationship between training medical and health personnel and a belief that such individuals view the public has having important views (r = .12). There was no relationship between journalist training activities and views about journalists.

Those who said they took part in informal training, however, were more likely to see benefits from both media training and public communication training for scientists (r = .12 and r = .13) and media training for regulators (r = .12). They were also less likely to believe that scientists/engineers and regulators think the public have important views (r = −.21 and r = −.17). Those who conducted informal training were more likely to believe scientists/engineers and regulators were out of touch with the public views about science (r = 21 and r = .14). Informal training experience was not associated with views about medical and health personnel.

Relationships Between Experience and Views About Scientists

Years of professional experience was marginally associated with training both regulators (r = .20) and medical and health personnel (r = .15), but not scientists and engineers or journalists. It was most heavily associated with informal training activity (r = .24). Such experience was associated with few substantive differences in views about any of the groups. The only relationships that did emerge were quadratic relationships between experience and a sense that scientists and engineers would benefit from media training (r = .18) and both a sense that regulators see the public as having important views (r = −.15) and are out of touch with the public (r = .13).

The only apparent relationship between years since obtaining one's final degree and views about science communication actors was a positive relationship with belief that science journalists' use credible sources (r = .20).

Relationships Between Subspecialty and Training Experience

Those who self-identified as science communication scholars were more likely to have done more training of scientists and engineers (r = .29) and journalists (r = .26) as well as more likely to say they had participated in more informal training (r = .19). Risk communication scholars were more likely to report training of journalists (r = .13) and informal training (r = .20). Self-identification as a health communication scholar was associated with training of science and health regulators (r = .15) and medical and health personnel (r = .27).

Additional Relationships Between Contextual Variables and Views About Scientists

Females were more likely to see benefits in media and public communication training for scientists and engineers (r = .19 and r = .22) and regulators (r = .23 and r = .22). Women were also more likely to view media training as beneficial to medical and health personnel (r = .14).

The number of papers that respondents reported publishing annually was associated with a lower sense of the value of media and public communication training for scientists. However, visual inspection of the linear relationships suggested that the relationship was not linear but quadratic for all groups, including scientists and engineers (r = −.18 and r = .27), regulators (r = −.15 and r = −.17), and medical and health personnel (r =.−14 and r = −.16). The difference between the linear and quadratic function was between −.02 and −.04 (average difference of −.03). The negative quadratic relationships reported highlight that whereas some initial publishing was associated with an increase in the perceived value of training, each additional publication per year (after one or two) was associated with less perceived value to training. Research productivity was not associated with views about any of the *deficit model* variables.

Scientist and engineer training was most often conducted by those who had received training funding from the NSF (r = .14), corporations (r = .21), and from within their own university (r = .17). Regulator training was associated with non-NSF/non-NIH federal funding (r = .28), nonprofit groups (r = .23), corporations (r = .16), and internal university funding (r =.14). Medical and health training was associated with NIH funding (r = .17), non-NSF/non-NIH federal funding (r = .30), nonprofit funding (r =.29), corporate funding (r = .18), and internal university funding (r = .26). Journalist training was associated with non-NSF/non-NIH federal funding (r = .15), corporate (r = .19), and internal university funding (r = .26). Lack of funding support was associated with not having conducted training of any group (average r = .26). Informal training was associated with funding from state governments (r = .21), nonprofits (r = .19), corporations (r = .15), and internal university funding (r = .13).

Discussion and Conclusions

The current study is based on the idea that it may be helpful for science communication scholars, including those who focus on science, health, and risk issues, to know about the nature of communication training being conducted by their colleagues. While a number of studies in recent years have asked what individuals involved in various scientific fields think about the public and about communication, the current work represents the first systematic attempt to study how communication scholars view the science community. Also, while we believe the current results are interesting in their own right, the true value of this research may emerge when it becomes possible to look at trends in communication scholars' views as a way of assessing progress in the area of science communication practice. The current results nevertheless point to a number of factors that deserve discussion.

First, the results on time spent training (Research Question 1) suggest that slightly more than half of the communication scholars who responded to the current survey *and* considered themselves an expert in the field reported conducting some formal science communication training. Journalists and regulators were the most commonly trained group, followed by medical and health personnel, and bench scientists and engineers. It is noteworthy that much of the literature (Dunwoody et al., 2009; Peters et al., 2008a, 2008b; Royal Society, 2006) focuses on bench scientists and engineers and their disconnect regarding the importance of communicating to the media and the general public. It is this same group of scientists, however, that get the least training. On the other hand, it is likely the group that has the least amount of day-to-day contact with the public, so the fact that one in five communication scholars report training bench scientists and engineers could be seen as a positive sign. Also, while it was not a major focus of the current study, the fact that two thirds of respondents indicated that they informally trained members of the science community in the past 3 years suggests that this is an area ripe for future analysis.

With regard to the type of training taking place (also Research Question 1), basic communication theories and models emerged as the most common focus of training; media training was least likely to be the focus of training across all groups. In some ways, training focused on communication theories are the furthest removed from actual interaction with the public. Furthermore, as Steve Miller et al. (2009) suggest, science communication curriculum for more discursive, theoretically focused topics are more challenging to develop and present, whereas "skill" or "practical" materials are easier to develop and perceived as beneficial by trainees. Future studies should expand upon the type and scope of training conducted by science communicators, perhaps examining exactly what is taught and why it is taught, what educational resources are drawn upon, and what training techniques are used.

Similarly, for science journalists, the focus was also on scientific concepts and processes, not actual writing or interviewing. Because previous research indicates that journalists who cover science and health have little training in the field and must rely on expert sources to explain scientific information and technical jargon (Corbett & Mori, 1999; Nelkin, 1996a, 1996b; Tanner, 2004), such training is a crucial step toward improving media coverage of science. The importance of such training is reiterated in other key findings from our study revealing that science communication scholars believe science stories appearing in the mass media lack comprehensiveness and accuracy. With journalism and mass communication industries facing steep revenue declines and seismic changes in the manner in which they conduct business (Project for Excellence in Journalism, 2009; Royal Society, 2006), few media organizations are willing, or able, to provide any type of training to their employees. As such, future research needs to continue to explore how mass communicators are being trained to present scientific topics to the public. Such efforts could—and should—be built into many existing and future training programs as part of any evaluation component.

The science communication scholars responding to our questionnaire reported that almost all members of the science community would benefit from both media training and training on communicating directly with the public (Research Question 2). This view is somewhat unsurprising, and even self-serving, but it lays the foundation for future research opportunities, particularly longitudinal research, which could shed light on whether different groups of the science community are getting better or worse in the eyes of communication scholars. It is also noteworthy that the only group whose communication scholars said that they did not need media training was the medical and health personnel. This may be linked to the fact that the medical community has increasingly focused on the importance of communication in the health care setting, ranging from doctor-patient relationships to communicating with the general public through mass communication. Nevertheless, because medical and health personnel primarily interact with the public directly and are seen as highly credible sources of information (Freimuth, 1987; Hesse et al., 2005), many experts contend that it is this group that should be involved more heavily in science communication (Covello, McCallum, & Pavlova, 1989).

Pertaining specifically to science that is channeled to the public through the mass media, several findings from this study reflect positively on how media cover scientific issues. When asked about their views on media coverage of scientific topics, science communication scholars, overall, did not believe that the media are hostile toward science. Respondents also agreed that media coverage of scientific topics was accurate. These findings concur with recent studies of the science-media relationship that suggest this interaction is more positive than previously thought (Dunwoody et al., 2009; Peters et al., 2008a, 2008b).

In fact, not only did the science communication scholars in the present study and the scientists examined by Peters et al. (2008a, 2008b) hold similar viewpoints about science journalism, but science communication scholars were actually more negative than scientists. For instance, communication scholars were more critical of the media's comprehensiveness of scientific issues and journalists' use of sources of information. One explanation could be that communication experts are simply critical of professional communicators because of proximity to the subject.

In the area of deficit thinking and views of the public (Research Question 4), our science communication scholars responded that they provided bench scientists and engineers with the least amount of training. However, these scholars also said that this group was the most likely to hold a deficit model perspective, the least likely to think the public have meaningful opinions, and the most likely to be out of touch with the public. However, the overall patterns of responses suggest that, in general, science communication scholars believe that members of the science community remain mixed in their views of the public. Some scholars think that the science community looks down on the public while others believe the science community has more positive impressions. Again, these are relationships that should be tracked over time. It should be hoped that, over time, those who have regular formal and informal training interactions with the science community should be the first to begin to see changes in how the science community views the public and the process of science communication.

The relationships between training experience, views about the science community, and our contextual variables highlight the broad agreement of science communication scholars on most topics. In this regard, relationships in the current data set are relatively small, and many of those that do exist are what would be expected. For example, it is not surprising that those with professional experience conducted more training as these individuals are likely to have more real-world communication experience and professional contacts and are perhaps more likely to have the capacity to translate academic research into useful training. Similarly, it makes sense that those involved in training particular groups (i.e., medical/health personnel or bench scientists) self-identified themselves as experts in specialties similar to that of their training focus.

Two sets of contextual relationships, however, may deserve some additional consideration. Perhaps the most surprising finding was the curvilinear relationships between academic publishing and views about the benefits of training. The meaning of this relationship, however, is unclear. Perhaps it represents a degree of cynicism on behalf of the least and most productive scholars, a lack of interest in hands-on training, or as Steve Miller (2008) suggests, a disconnect between practical, day-to-day science communicators and science communication scholars.

Several limitations should be considered when interpreting the findings. This study surveyed scholars producing research in five academic journals. While the journals selected are key to the various subfields examined in this study, the authors acknowledge that science communication experts publish in a range of other venues. For example, those who produce books or publish professionally-oriented material were not included in our population of science communication scholars. Ideally, this type of research might draw on lists from relevant subgroups of academic organizations (e.g., the International Communication Association's health communication division; the Association for Education in Journalism and Mass Communication's research group on science, health, the environment, and risk; the Society for Risk Analysis' risk communication division; and the American Public Health Association's public health education and health promotion section) but not all these organizations were willing to share membership lists. Nevertheless, as pointed out by Steve Miller (2008), there is a perception that science communication practitioners are disconnected from the relevant literature in the field, and one of the strengths of this study's methodological approach is that it provides important insight from science communication experts who conduct training and also publish research in key science communication journals. This procedure for creating a research population is also consistent with previous research on scientists' views (Besley et al., 2008; Peters et al., 2008a, 2008b) and seemed the most systematic method of gaining access to science communication experts across the subdisciplines of science, health, environment, and risk.

Another limit is the focus on training of scientists and engineers, regulators, and medical and health personnel. Future research could explore training of additional groups involved in scientific debates, including corporate training and training of nongovernmental actors. Both these groups play an important role in mediated discussions about science, risk, and health, making them deserving of future attention.

While the current study focused on views about communication by members of the science community, the type of data underlying the analyses could also be used for other types of research. In particular, it may be interesting to look at relationships between the subfields of science, health, and risk communication as well relationships among other academic disciplines. In the current study, there appeared to be similarities in the views of those who identified as science and risk communication. These types of relationships may be helpful in understanding what the authors believe are related areas of scholarly endeavor. Other types of analyses such as citation analyses, analyses of coauthor departmental identification, and analyses of research center and group names could be similarly used to answer questions about those engaged in the study of science, health, environment, and risk communication.

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Notes

1. In *Risk Analysis*, only articles focusing on risk communication were included in the study. These articles were identified using "communication" as keyword for searching in the abstract and keyword list.
2. If an author's corresponding university was known, the university website was accessed to obtain an e-mail address. If an author's university was unknown, common Internet search engines, such as Google as well as university-specific search

engines when the university was indicated, were used to search for an author's contact information.

3. SurveyMonkey (www.surveymonkey.com) was used to design the questionnaire and collect data. The questionnaire can be obtained by contacting the authors.

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