Building buzz: (scientists) communicating science in new media environments

Xuan Liang[1]
xliang3@wisc.edu

Leona Yi-Fan Su[1]
su28@wisc.edu

Sara K. Yeo[1]
skyeo@wisc.edu

Dietram A. Scheufele[1]
scheufele@wisc.edu

Dominique Brossard[1]
dbrossard@wisc.edu

Michael Xenos[2]
xenos@wisc.edu

Paul Nealey[3]
nealey@uchicago.edu

Elizabeth A. Corley[4]
corley.elizabeth@gmail.com

[1] Department of Life Sciences Communication,
University of Wisconsin – Madison, USA

[2] Department of Communication Arts,
University of Wisconsin – Madison, USA

[3] Institute for Molecular Engineering,
The University of Chicago, USA

[4] School of Public Affairs,
Arizona State University, USA

Abstract

Public communication about science faces a set of novel challenges, including the increasing complexity of research areas and the erosion of traditional journalistic infrastructures. Although scientists have traditionally been reluctant to engage in public communication at the expense of focusing on academic productivity, our survey of highly cited U.S. nano-scientists, paired with data on their social media use, shows that public communication, such as interactions with reporters and being mentioned on Twitter, can contribute to a scholar's scientific impact. Most importantly, being mentioned on Twitter amplifies the effect of interactions with journalists and other non-scientists on the scholar's scientific impact. Our study provides one of the first comprehensive empirical examinations on the impact of various media outreach on scientists' academic career that combines survey data with data on social media (e.g., Twitter) usage. The results may eventually force academics to think more carefully about defining academic impact in a world of sites, which combine social media metrics with indicators of scholarly productivity to measure the broader impact of academic work.

Introduction

For many researchers, dissemination of research results to a general public rarely entails more than a press release through their institution's public relations division, and possibly a follow-up interview with a journalist. Only a minority of scientists have been actively engaged in communicating science through popular media outlets. Among them are prominent and highly visible researchers, such as Carl Sagan, Richard Smalley, and Neil deGrasse Tyson. In spite of these visible exceptions, there continues to be a normative assumption among scientists that public communication is not valuable or even detrimental for their academic career. Scientists are expected to be modest and dedicated to their research rather than trumpeting their works in popular media (Shortland & Gregory, 1991). The rewards of communicating science through traditional media are thus believed to compromise a scientist's integrity and authority (Dunwoody & Ryan, 1985; Mellor, 2010). In fact, the term "Sagan-ization" is often used to describe scientists who "become popular enough as an explainer of science to risk the contempt of more 'serious' researchers" (Kennedy, 2010, p. 9). This is a reference to the widely held notion that the popular Cornell astrophysicist, Carl Sagan, was denied admittance to the National Academy of Sciences because of his publicly televised series, *Cosmos* (Dean, 2009).

The Internet has fundamentally changed our modern media environments and audiences' media consumption habits (Anderson, Brossard, & Scheufele, 2010; Brossard & Scheufele, 2013). With social media and Web 2.0-type tools, the boundaries of communication that exist between scientists, journalists, and public audiences become blurrier. Through blogging services and social media, scholars now have the opportunity to communicate about their work directly with various publics in addition to the traditional outreach efforts. Twitter, for example, provides unique opportunities for scientists to post 'tweets,' user-generated content with a limit of 140 words. Information shared on Twitter by certain opinion leaders, including some prestigious science writers, can immediately reach a large number of audiences. For example, every tweet from Carl Zimmer may be seen by over 146,000 followers and potentially greater audiences when the post is retweeted by these followers.

However, the question remains whether public communication efforts by scientists yield any rewards. Researchers have yet to investigate empirically and agree on the impact of communicating one's work in various media, particularly online media, on scholars' advancement within the ivory tower. Our study fills this gap in the literature by exploring whether public outreach via traditional and online media can boost scholars' scientific impact as measured by the *h*-index.

Methodology

Sample. Our sample consists of only the most highly cited U.S. scientists within the field of nanotechnology in the United States. Nanotechnology is an emerging and complex field that encompasses a broad area of expertise, drawing from the fields of chemistry, materials science, physics, engineering, biology, and others. Its inventions are integrated with modern biology, the digital revolution, and cognitive sciences (Roco & Bainbridge, 2003). The reasons that we focus on nano-scientists are twofold. First, elite experts in one discipline may not enjoy equivalent reputation in another discipline. By focusing on scientists working in this multidisciplinary field, we can remove the effects of name recognition, which otherwise can be a confounding factor that influences citation patterns. Second, the multidisciplinary nature of nanotechnology makes nano-scientists especially pertinent and representative of scientists who work in an evolving scientific community in which the distinctions between disciplines are blurring and research endeavors require interdependence among disciplines.

We sampled authors of the most cited publications that were indexed in the ISI Web of Knowledge database in 2008 and 2009 so as to minimize the potential confounding effects of seniority on the *h*-index (Hirsch, 2005; Kelly & Jennions, 2006). In order to rigorously establish which publications were actually within the multidisciplinary field of nanotechnology, we relied on a database that indexed a total number of 189,014 nanotechnology-related journal articles published in the two-year period (2008-2009). In particular, this database of nanotechnology publications was built upon a set of bibliometric search terms that define the domain of nanotechnology-related publications (Porter, Youtie, Shapira, & Schoeneck, 2008). Using this database, we identified a sample of 1,405 U.S.-affiliated authors of the most highly cited nanotechnology publications, each of whom was cited no less than 39 times in the two-year period.

Data collection. Data for the study were collected in two parts. First, a nationally representative survey of leading U.S. nano-scientists was collected by mail. The survey was fielded in four waves between June and September 2011, following Dillman, Smyth, and Christian's tailored design method (2008). The mail survey yielded 444 completed questionnaires, with a final response rate of 31.6%, following American Association for Public Opinion Research's method of Response Rate 3 (AAPOR, 2011). We surveyed respondents about their perceived interactions with journalists and lay publics and their frequency of science blogging.

We then tracked respondents' academic impact using the *h*-index (Hirsch, 2005), a measure that includes the number of peer-reviewed articles published and the number of citations accrued and embodies a figure of merit (van Raan, 2006). In order to examine a link between scientists' public communication behaviors and indicators of scientific impact, we allowed respondents' *h*-indices to accumulate over a period of 15-18 months following our survey and thus collected the second part of our data in December 2012 from the ISI Web of Knowledge database. We also recorded their research mentioned in others' tweets at this time. Our analysis focused only on scientists in tenure-track faculty positions while scientists associated with private industry and in federal government positions (e.g., U.S. Department of Agriculture or U.S. Environmental Protection Agency) were excluded. Our final sample was 241 U.S. nano-scientists.

Measures. We used the *h*-index (M = 37.1, SD = 23.7) as a measure of a researcher's *scientific impact*. To obtain a measure of scientists' *interactions with reporters* we asked respondents how often, based on a 4-point scale (1 = "Never," 4 = "Often"), they spoke to reporters about their research findings (M = 2.6, SD = 0.9). *Interactions with other non-scientists* was measured by asking respondents how often they talked with non-scientists about their research findings. Responses were coded on the same scale (M = 3.1, SD = 0.7). *Science blogging* was gauged by asking respondents how frequently, using the same 4-point scale, they wrote a blog about science (M = 1.3, SD = 0.6). We defined mentions on Twitter as tweets from any Twitter user that referred to the respondent's name and research with hyperlinks to detailed information. Due to the low number of tweets that mentioned respondents' research, we chose a dichotomous variable to indicate whether the participant's own research had been *mentioned on Twitter* (14.1% were mentioned on Twitter).

We controlled for participants' *gender* (85.9% male), *scientific age* (the number of years since his or her first publication, M = 21.2, SD = 10.7), *tenure* (whether they were tenured faculty members; 73.8% tenured), and their *disciplinary field* in which they received their doctoral degree (33.1% chemistry, 17.2% physics, 17.6% engineering, 14.2% materials sciences, and 17.9% biology and other sciences) because of sensitivity of the *h*-index to these factors (Hirsch, 2005; Kelly & Jennions, 2006).The disciplinary variables were entered in the regression model as a series of dummy variables, with biology and other sciences as the reference group.

Data analysis. We tested our hypotheses and research questions using a hierarchical ordinary least squares (OLS) regression model. The variables were entered in blocks according to their assumed causal order. In the model, the blocks were ordered as follows:

1. Demographics and professional status (*gender, scientific age, tenure*)
2. Disciplinary field (*chemistry, engineering, physics, materials sciences*)
3. Public science communication (*interactions with reporters, interactions with non-scientists, science blogging, mentioned on Twitter*)
4. Two-way interactions

Results

Overall, our model fit the data well, with variables included accounting for 60% of the variance in *h*-index. Senior researchers, or those who had published their first paper earlier relative to others in the sample, had higher *h*-indices. Tenured scholars also had higher *h*-indices than those who were not tenured. We found a positive relationship between interactions with reporters and *h*-indices ($\beta = .22$, $p \leq .001$), implying that scholars who had more interactions with reporters had greater scientific impact than those who had fewer interactions with reporters. Interactions with other non-scientists and science blogging were not significantly related to *h*-indices (Table 1). Scientists whose research was mentioned on Twitter had significantly higher *h*-indices ($\beta = .13$, $p \leq .01$) than their peers whose research was not mentioned on Twitter (Table 1). Additionally, we found two significant interactions (Table 1). The interactive effect between scientists' interactions with reporters and being mentioned on Twitter was positive (β = .14, $p \leq .05$). Being mentioned on Twitter also further amplified the effect of interactions with other non-scientists on the *h*-index (β = .11, $p \leq .05$) (Table 1). In other words, interactions with reporters had a significantly higher impact on *h*-index for those scientists who were also mentioned on Twitter than for those who were not (Figure 1). The *h*-indices of scientists who interacted with other non-scientists were higher if they were also mentioned on Twitter compared to scholars who were not (Figure 2).

Table 1. OLS regression model predicting *h*-index (N = 241).

	Zero-order	β
Block 1: Demographics and professional status		
Gender (female=1)	-.08	.02
Scientific age	.70***	.54***
Tenure (tenured =1)	.54***	.14*
Incremental R^2 (%)		*51.2****
Block 2: Disciplinary field		
Chemistry	.04	-.02
Engineering	-.13	-.10
Physics	.04	-.05
Material Science	-.06	-.07
Incremental R^2 (%)		*.2*
Block 3: Public science communication		
Interactions with reporters	.34***	.22***
Interactions with other non-scientists	.18**	.02
Science blogging	-.03	-.06
Mentioned on Twitter (mentioned =1)	.23***	.13**
Incremental R^2 (%)		*6.5****
Block 4: Two-way interactions		
Interactions with reporters × Interactions with non-scientists	–	.08
Interactions with reporters × Science blogging	–	.01
Interactions with reporters × Mentioned on Twitter	–	.14**
Interactions with non-scientists × Science blogging	–	.03
Interactions with non-scientists × Mentioned on Twitter	–	.11*
Science blogging × Mentioned on Twitter	–	.04
Total R^2 (%)		*60.0*

***$p \leq .001$, **$p \leq .01$, *$p \leq .05$. Cell entries are final standardized regression coefficients for Blocks 1, 2, 3 and before-entry standardized regression coefficients for Block 4.

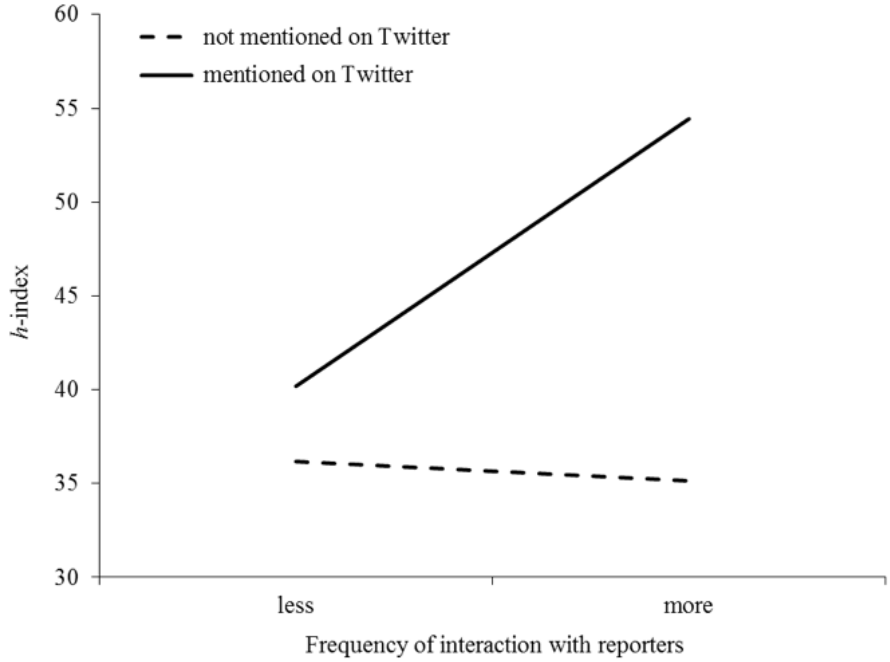

Figure 1. Interactive effect between frequency of interaction with reporters and being mentioned on Twitter on *h*-index. *Note*: Scale on y-axis is only partially displayed.

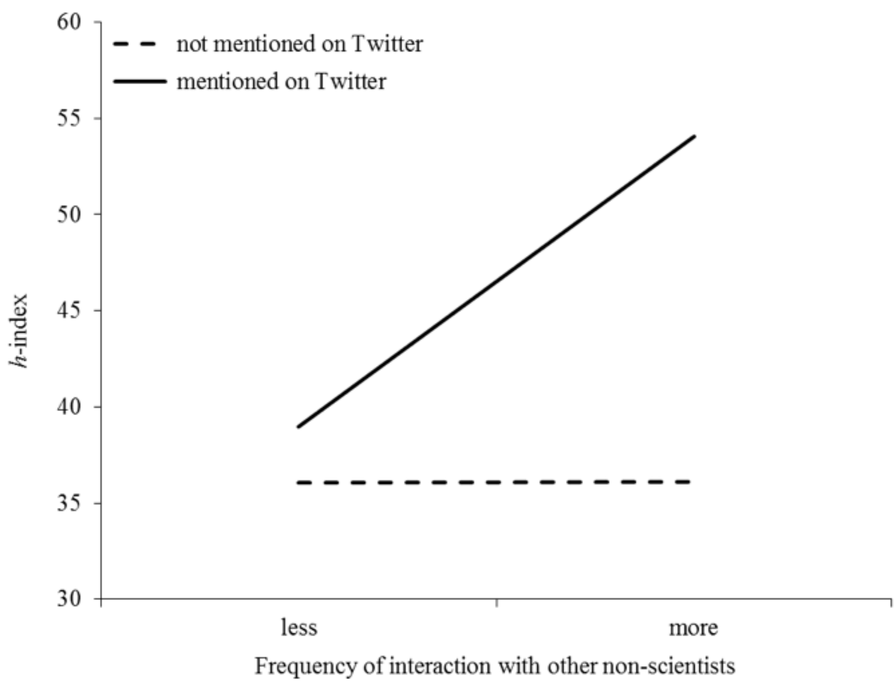

Figure 2. Interactive effect between frequency of interaction with other non-scientists and being mentioned on Twitter on *h*-index. *Note*: Scale on y-axis only is partially displayed.

Discussion

The current study provides the first comprehensive empirical evidence that outreach activities, such as interactions with reporters and being mentioned on Twitter, can assist a scientist's career by promoting his or her scientific impact. More importantly, online buzz (e.g., being mentioned on Twitter) further amplifies the impact of communicating science through traditional outlets on the scholar's scientific impact. Before elaborating on the implications of our findings, however, it is important to be aware some aspects of our data.

The issue of endogeneity, if not addressed appropriately, could confound our evaluation of the effects of various communication behaviors on one's scientific impact. For example, scientists were likely to come from elite educational institutions, have published a number of highly impactful papers, and were therefore covered more frequently in the media. In this study, the issue of endogeneity is minimized in three ways. First, as presented above, we focused on a heterogeneous sample of the most highly cited scientists. Second, we collected scientists' *h*-indices about one-and-a-half years after surveying their communication behaviors. Third, we controlled for the factors that might be correlated with both scientists' communication behaviors and their scientific impact, e.g., gender, and professional status (scientific age, whether the respondent was tenured, and disciplinary field). As a result, we observed a significant and positive association between active communication behaviors and the *h*-index after their communication behaviors. It is reasonable to assume that the strength of the observed associations would increase if we adopted a longer time period to allow *h*-indices to accumulate following various communication behaviors.

This study refines our understanding of science communication in the contemporary media landscape where the online environment gains prominence and traditional science reporting shrinks in volume. Future research is encouraged to compare the impacts of outreach activities for scientists with different affiliations (such as a industry-based, government-based, versus university-based comparison) and from other research disciplines. We aso encourage attempts to obtain continuous variables of both active and passive activities on social media, such as frequencies of reposting one's own research, posting comments on other's research, and one's research being mentioned.

Conclusion

Although some scholars may continue perceive public communication efforts as detrimental to career advancement, our evidence suggests public communication efforts by scientists will have rewarding paybacks. As the definitions of expert and public communication continue to change, and the media environment and public audiences adapt to it, the essential question is no longer whether scientists should engage with the media, but how to do so effectively.

References

AAPOR (2011), Standard definitions: Final dispositions of case codes and outcome rates for surveys, Lenexa, KS.

Anderson, Ashley A., Dominique Brossard, & Dietram A. Scheufele (2010), "The changing information environment for nanotechnology: Online audiences and content," Journal of Nanoparticle Research, 12, pp. 1083-1094.

Brossard, Dominique, & Dietram A. Scheufele (2013), "Science, new media, and the public," Science, 339, pp. 40-41.

Dean, Cornelia (2009), Am I making my self clear? A scientist's guide to talking to the public, Cambridge, MA, Harvard University Press.

Dillman, Don A., Jolene D. Smyth, & Leah Melani Christian (2008), Internet, mail, and mixed-mode surveys: The tailored design method, Hoboken, NJ, Wiley.

Dunwoody, Sharon, & Michael Ryan (1985), "Scientific barriers to the popularization of science in the mass media," Journal of Communication, 35, pp. 26-42.

Hirsch, Jorge E. (2005), "An index to quantify an individual's scientific research output," Proceedings of the National Academy of Sciences of the United States of America, 102, pp. 16569-16572.

Kelly, Clint D., & Michael D. Jennions (2006), "The h index and career assessment by numbers," Trends in Ecology & Evolution, 21, pp. 167-170.

Kennedy, Donald (2010), "Science and the media," en Donald Kennedy, & Geneva Overholser, Science and the media, Cambridge, MA, American Academy of Arts and Sciences, pp. 1-10.

Mellor, Felicity (2010), Negotiating uncertainty: Asteroids, risk and the media. Public Understanding of Science, 19, pp. 16-33.

Porter, Alan L., Jan Youtie, Philip Shapira, & David J. Schoeneck (2008), "Refining search terms for nanotechnology," Journal of Nanoparticle Research, 10, pp. 715-728.

Roco, Mihail C., & William Sims Bainbridge (2003), Converging technologies for improving human performance, Dordrecht, Netherlands, Kluwer Academic Publishers.

Shortland, Michael, & Jane Gregory (1991), Communicating science. A handbook, New York, Longman.

van Raan, Anthony F. J. (2006), "Comparison of the Hirsch-index with standard bibliometric indicators and with peer judgment for 147 chemistry research groups," Scientometrics, 67, pp. 491-502.