RePoSS: Research Publications on Science Studies

RePoSS #37:

Surveying nanoscientists' communication activities and online behavior

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February 2016

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Please cite this work as:

Bircan Aykurt (2016). *Surveying nanoscientists' communication activities and online behavior*. RePoSS: Research Publications on Science Studies 37. Aarhus: Centre for Science Studies, University of Aarhus. URL: http://www.css.au.dk/reposs.

MASTER'S THESIS

SURVEYING NANOSCIENTISTS' COMMUNICATION ACTIVITIES AND ONLINE BEHAVIOR

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Abstract

Digital revolution changed the way we reach information. Science news sections are disappearing and online tools are becoming the prefered source of information over the traditional channels. As public communication activities are highly important for the course of science, especially for emerging technologies, this study investigates public communication activities and online behaviour of nanoscientists currently working at Interdisciplinary Nanoscience Center at Aarhus University.

First, a survey consisted of 31 questions was e-mailed to nanoscientists in order to measure their communication activities in the last 5 years (2010 - 2015) and to determine which factors are related to their willingness to engage with both the media and the lay audiences. Following the survey, two scientists that reported low online activity were interviewed. Results were compared to Dudo et al. (2014) for a comparison between Danish and American nanoscientists.

Survey results did not indicate a high online presence in terms of communicating science. Scientists are mostly readers on online channels rather than sharers. Engagement with the media is found to be related to their previous contact, use of online tools to communicate about science, presumed media influence and media motivations while engagement with the public is spurred by the thought that it is important for the society.

The data showed that the sample has more contact with the public than the media. This is encouraging in concluding that the sample is bypassing media professionals in reaching the public.
However, the sample reported less contact with the media and the public in comparison to the American sample and they reported less agreement with the statement that the contact with the media and the public had a positive impact on them professionally.

Lack of time, overlapping professional and private networks, the concern of quality and the difficulty in explaining research can be counted as the reason for the low online presence for the nanoscientists in the sample.

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1 Public Communication of Science and Technology

“Science offers means to use unprecedented powers with which a finer, more beautiful and happier world than ever can be built. With mankind using a vigorously developing science for social ends, the future can be bright and inspiring.”
(Association of Scientific Workers, 1947, p.249)

1.1 Milestones

The debate about the relationship between science and public dates back to the efforts in Britain in the 19th century. The lack of skilled workers was seen as an obstacle towards industrial and technical developments in the Industrial Revolution and Mechanics Institute was founded in 1821 “to address societal needs by incorporating fundamental scientific thinking and research into engineering solutions" (Crystal & Laundon, 2015). The purpose was to connect working class people with scientific knowledge by offering training in science and technology throughout the country (Irwin,1995).

In 1947, Association of Scientific Workers was founded and the following three items were listed as reasons for a better public understanding of science: (Irwin, 1995, p.11)

- a technical-literate population is essential for future workforce requirements,
- science is now an essential part of our cultural understanding and
- greater public understanding of science is essential for democratic reasons.

The Association also made recommendations in regards to better public understanding through different media(films, press, radio, museums etc.) Another suggestion was that scientists should become more involved in public activities and in the dissemination of science.

The Public Understanding of Science Report[1] (also known as The Bodmer Report named after the group leader Dr. W.F. Bodmer) which was published in 1985 by Royal Society is a milestone for PUS movement. The report listed three undesirable consequences to the lack of public understanding of science: slow economic growth, a populace incapable of making the decisions about important matters and a scientifically ignorant public which in one way denies its roots as science shapes the modern societies. It also underlined that our societies are heavily scientific and technological and, therefore, all related decisions require an understanding of science. The report continued by making suggestions in regards to public, media, education system, industry, scientists and Royal Society itself. Public requires science to be able to make decisions about their daily lives, schools should provide the youth with adequate basic knowledge about science, media should spare more space for science news and understanding, industry should hire more scientists and bring them into managing positions, scientists should learn to

[1] (The Royal Society of London, 1985) Full report can be found at https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/1985/10700.pdf

communicate their science and talk with the public, and Royal Society should make PUS one of its major goals and continue its efforts to improve public understanding of science (The Royal Society of London, 1985, p.6). It is worth mentioning that the report was published during 80's when science witnessed cuts in funding (Irwin, 1995). PUS movement was therefore seen as a catalyzing element for more public support to science as the underlying assumption was that appreciation of science within public could be achieved by a better understanding of science.

Another milestone for public communication of science is the House of Lords Select Committee's report on science and society in 2000.[2] The report identified a lack of trust within public towards scientific authority in Britain albeit high interest in science. A new mode for dialogue was therefore suggested by the report and this mode included, among others, that scientists should receive communication training, scientists should be more involved in the social contexts of their field and research, research should be shared with the public, independent sources should be provided on the web, dialogue with the public should be an integral part of science policy making. The report followed with more recommendations to scientific organizations and governmental bodies on how to advance the dialogue mode which is open to discussions and questions, paving the way to Public Engagement of Science which is now a term that covers a variety of activities.[3]

In 2010 European Commission published a report on Science and Technology which suggested that trust towards scientists was still lacking in Europe while the interest remained high. 58% agreed with the statement that "scientists can not be trusted to tell the truth about controversial scientific and technological issues because they depend more and more on money from industry" and 63% chose scientists that are working in universities or governmental laboratories as best qualified to explain the impact of scientific and technological developments on society.(European Commission, 2010).

1.2 Frameworks

Under the dome of these two paradigms, Public Understanding of Science and Public Engagement of Science and Technology, different frameworks are established. Three of which will be described in this section based on Brossard and Lewenstein (2012), Research International (2000) and Trench (2008b).

Figure 1 consists of Brossard and Lewenstein account of the model in scientific communication. The deficit model or the cognitive deficit model rests on the idea that public is in the lack of basic scientific knowledge. The concerns to fill in that gap led to attempts to measure public knowledge and attitude towards science. Deficit model lies on the premise that understanding of science will lead to better decision-making and appreciation towards science.

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[2] Report can be accessed at: http://www.publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3802.htm

[3] Here it is noteworthy that Russell (2010) divides scientific communication under the two paradigms, PUS and PEST and this study follows his account.

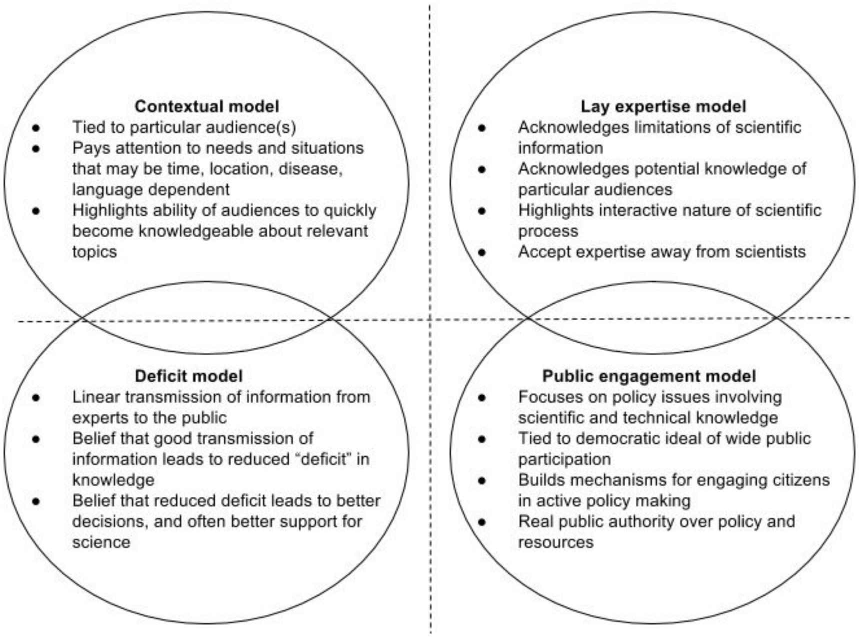

Figure 1. Conceptual models of public understanding of science (Brossard and Lewenstein, 2012)

The contextual model, on the other hand, emphasizes that humans are not "empty containers" that receive knowledge and store it, instead we process the information we receive based on cognitive shortcuts (Brossard & Lewenstein, 2012, p.13). Previous experiences, cultural context, beliefs, social and psychological processes are at play when processing information. Marketing segmentation was used in the contextual model to reach different groups with a carved strategy that would be suited to approach each segment. Office of Science and Technology & Wellcome Trust, for example, identified six groups after their survey in 2000: Confident Believers, Technophiles, Supporters, Concerned, Not Sure and Not For Me. They state that the deficit model was "less relevant" then and they aim to start a discussion about "engagement model of Science and Society" (Office of Science and Technology & Wellcome Trust, 2000).

Lay knowledge is defined as information gathered about the world around us outside the scientific methodology by laymen. Brossard and Lewenstein defined the lay expertise model as " the model that argues that scientists are often unreasonably certain – even arrogant – about their level of knowledge, failing to recognize the contingencies or additional information needed to make real-world personal or policy decisions." (2012, p.15). It underlines that in different fields there is an accumulated lay knowledge that is based on daily life practices which science can benefit from and, that practice and theory do not necessarily share the same values.

Public engagement model (also referred to as the dialogue model in Britain) focuses on the participation of the public in science policy and science. This is achieved through "consensus conferences, citizen juries, deliberative technology assessments, science shops, deliberative polling" (Brossard & Lewenstein, 2012) etc. Two-way communication forms the base in this model.

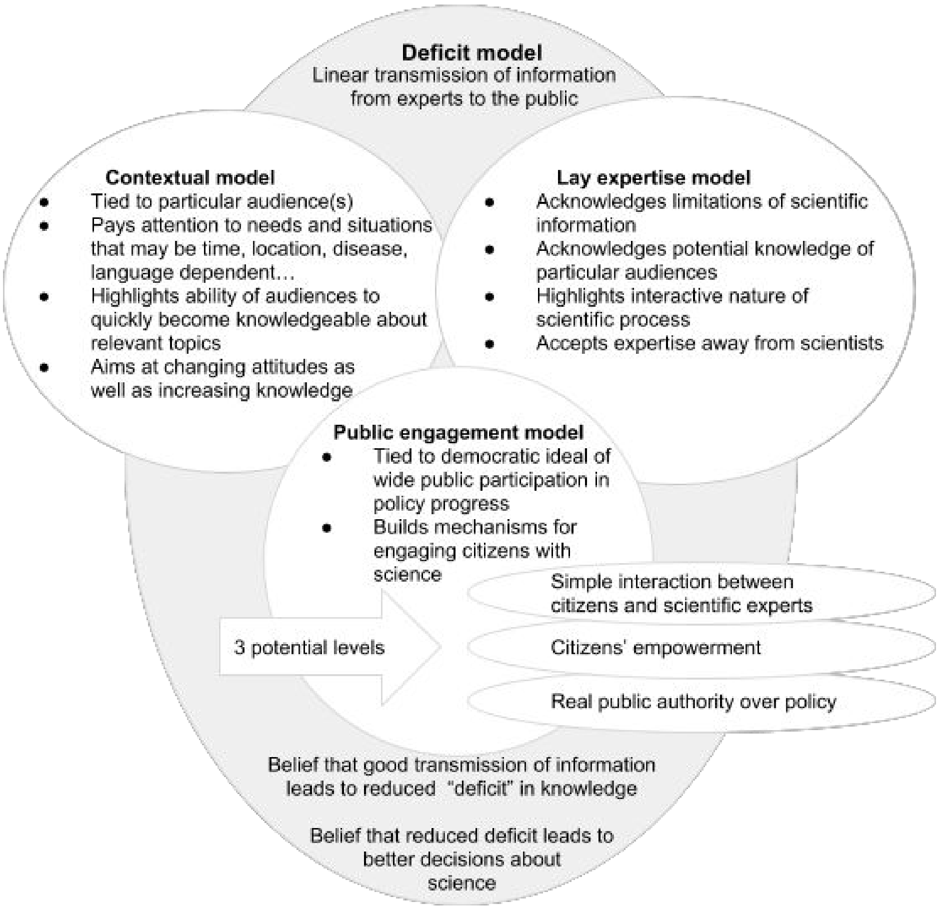

Figure 2. Public communication methods in outreach setting (Brossard and Lewenstein, 2012)

Brossard and Lewenstein argue, after surveying some examples that these concepts does not capture the reality of the actual communication activities. In *Figure 2*, they show that the deficit model forms a backbone in such activities. The key points are then to identify the publics of interest, that there is a consensus to what information needs to be disseminated and that engagement as a term is problematic as the engagement can happen in different stages and the public might not be engaged when scientist expect them to engage.

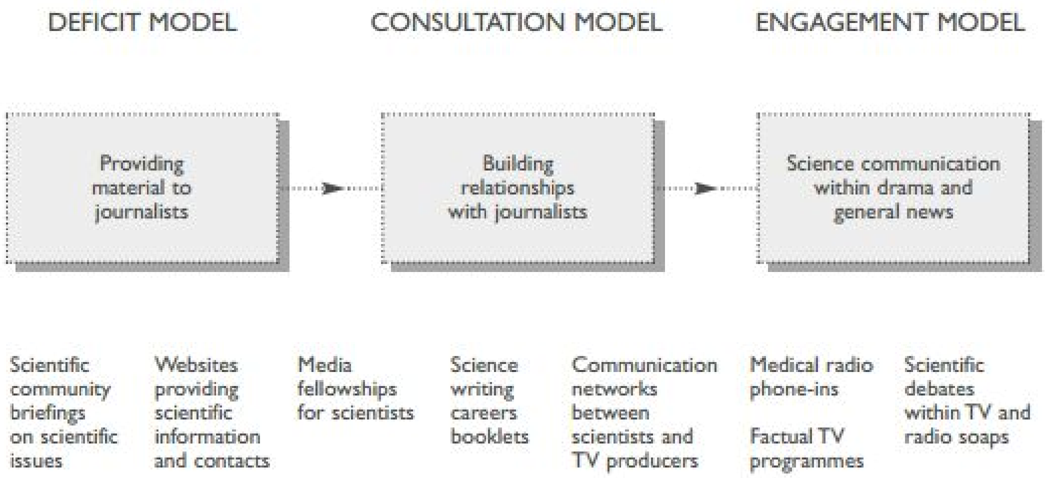

Figure 3. Media related activities
(Research International, 2000)

Figure 3 shows the three stages science reaches the public through media which represents three models according to Research International, a British research company which was commissioned by The Consultation and Education section of the Wellcome Trust[4] to review science communication activities in Britain. Here it is noteworthy that this is a projection of the science communication models on media, that the receiver is, first of all, the media and, therefore, the media needs to be informed before the public.

Trench argues that there is not an actual shift from the deficit model (PUS) to dialogue model (PEST). These models could co-exist and deficit model still proves to be a significant part of science communication and dialogue model refers to a variety of activities. This analysis is analogous to Brossard and Lewenstein remark on the public outreach activities (see Figure 2).

According to Einsiedel (2000), these models should be seen “complementary rather than mutually exclusive”.[5] Trench thereby provides his own classification of concepts. As can be seen in the table above, his classification has 3 base models, his deficit model is similar to those discussed above and in dialogue model, he refers to a two-way communication about the dissemination of science and its applications. In participation model then, all groups can actually make a contribution and the communication happens back and forth between the public and scientists.

[4] Welcome Trust is a “global charitable foundation dedicated to improving health by supporting bright minds in science, the humanities and social sciences, and public engagement.” http://www.wellcome.ac.uk/index.htm
[5] As quoted on (Trench, 2008b)

Table 1. Analytical framework of science communication models

Base Communication Models	Ideological and Philosophical Associations	Dominant Models in PCST	Variants on Dominant PCST Models	Science's Orientation to Public
Dissemination	Scientism		Defense	They are hostile.
		Deficit		They are ignorant.
	Technocracy		Marketing	They can be persuaded.
Dialogue	Pragmatism		Context	We see their diverse needs.
		Dialog	Consultation	We find about their views.
	Constructivism			They talk back.
			Engagement	They take on the issue.
Conversation	Participatory Democracy	Participation		They and we shape the issue.
			Deliberation	They and we set the agenda.
	Relativism		Critique	They and we negotiate meanings.

(Trench, 2008b)

1.3 Science-Media Relations

> *Whatever we know about our society, or indeed about the world in which we live, we know through the mass media.This is true not only about our knowledge society and history but also of our knowledge of nature. What we know about the stratosphere is the same as what Plato known about Atlantis: we've heard tell of it.* (Luhmann, 2000, p.1)

In the intersection between science and the media, Peters (2013, p.14102) compiles the metaphors and terms that are used to describe that relationship: distance, gap, barrier, fence, oil and water, and creative tension.[6] As science and media function on different norms and values, as the ethics and driving forces differ, such metaphors are not hollow. "Science values detail, precision, the impersonal, the technical, the lasting, facts, numbers and being right. Journalism values brevity, approximation, the personal, the colloquial, the immediate, stories,

[6] On the accounts of (Hartz & Chappell, 1997), (Maille, St. Charles & Lucotte., 2010), (Dunwoody & Ryan, 1985), (Schneider, 1986), (McCall, 1988) and (Nelkin, 1989) as cited in (Dunwoody, 2014)

words and being right now. There are going to be tensions." writes science journalist Quentin Cooper. [7]

Media pursues stories that have news value "a property which involves subjective judgments about likely audience interest." (Russell, 2010, p.138-139). The stories that are current, important, happening close by, sensational, or related to conflicts are of news value. Their work has to provide correct information, protect the individual integrity, be impartial or neutral, at the same time they are run as parts of corporations and that creates financial pressure and competitiveness. The financial pressure can result in providing too much entertainment which brings in more ratings comparing to other subjects such as science news. On the other hand, scientific community works on universal criteria and scientists are supposed to be disinterested in their work and they are skeptical about the claims.[8]

Dunwoody (2014) gives a summary of who writes science stories. While at first being an endeavor for scientists to spread the scientific knowledge in the early 19th century, scientists retracted from that role which was going to be lent to journalists by the 20th century. With the establishment of popular science magazines in the late 19th century, the popularisation of science was intertwined with the scientific work. Dunwoody states that in early 20th century scientists started to specialize and started to form their own culture and separated from the public. The perception of scientists in the popularization of science was punished by some scientific societies, which also added to the reason why scientists left the role to journalists later on. Even in mid 20's, specialized science reporting was not favored, as it was expensive and rare until conditions changed in post-war time. Science journalism, then, started to be organized and associations were formed even though science journalists formed a small part of the journalistic world. As it will be mentioned in the next chapter, at the moment, science sections are very few in the media, some journals are both in the business of publishing scientific articles and constructing news stories based on those articles, there is a shift to online channels in science news (p.27-29).

Media's interest and report of science nowadays rest on two facts, science is news in itself and science is newsworthy as it is relevant to the non-scientific news. As our societies are getting more technical and scientific, science has also gained a type of commentator role. Similarly, based on the studies on the newspaper coverage, Dunwoody (2014) states that "science journalists may be making a conceptual distinction between news and news you can use, with the latter focusing more heavily on health and medicine topics" (p.31).

1.4 Chapter Conclusion

In this chapter, I briefly summarized paradigms and some concepts of public communication of science together with an account of science and media relationship.

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[7] http://blogs.independent.co.uk/2011/09/27/science-and-the-media-%E2%80%93-an-uncomfortable-fit/

[8] Mertonian norms: Communalism, universalism, disinterestedness, organized scepticism

According to Beck (1992), we live in a risk society where we deal “with hazards and insecurities introduced by modernization itself” (p.21). Developments in science and technology are indeed a huge part of this modernization as we face more human-made issues in our societies. The notion of risk society, therefore, calls for “active engagement between scientists, technologists, policy makers, interest groups and others, to assess current trends in and future implications of developments in science and technology” (Trench, 2008b, p.137).

Knowledge society, on the other hand, centers knowledge in its core as the capital, therefore, science and technology are highly valued and the society is in the making of knowledge. These notions underline the need and importance of scientific communication and they also point out the centrality of knowledge in our societies. Knowledge is not only what public benefits from, but it is what forms and drives our modern societies.

“A theoretical understanding of the processes at play in online environments will have to be achieved at a faster rate if science wants to leverage the online revolution for successful public engagement,” states Brossard (2013, p.14100) But how do these concepts that are discussed in this chapter go together with the online revolution? Following lines include preliminary thoughts and the next chapter will go deeper in this topic.

What online channels can provide fits Trench’s framework. Internet allows communication and engagement in different levels. It can serve the deficit model and broadcast information to audiences and aim to get the public more interested in science. It can serve the contextual model by providing scientific information in practical contexts. It can serve the lay expertise model and build bridges between experts and laymen for a beneficial information exchange. It can definitely serve the public engagement model as it provides an environment which allows a two-way communication. All these models co-exist in the age of internet but as in *Figure 2* deficit model or a one-way information flow will present the backbone where other models can rest on.

The thoughts above mark the potential yet there is a need to understand what is actually carried out in practice. How do scientists communicate their science in specific fields? Which concepts do they follow? Is this a conscious choice? What drives do they have in communicating their science in their field? How are scientific communities in different national contexts act in comparison to one another? With these considerations, next chapter will look into online channels in scientific contexts and investigate the recent changes in these contexts for science communication.

2 Web and Social Media

2.1 News Consumption

Traditional media is transforming into online channels in the information age as the industry declined by 40% in the last decade[9] and the advertising in newspapers is declining as well (Dunwoody, 2014, p.29). World wide web is becoming the preferred source of news over the printed media. Television still leads the way in reaching the news within American public by 55%, followed by internet 21% and print media 9% in 2013.[10]

According to a report by NSF(National Science Foundation)[11] in 2012, almost half of the information consumers that preferred online outlets relied on sources other than journalistic ones, meaning search results, social media, blogs etc. Similarly, scientists themselves also rely on such sources to follow up on the recent science news in their fields in an era where 95 weekly science sections in 1989 declined down to 19 in 2012.[12] These sources and online tools have witnessed a huge expansion and social media channels have an immense number of users, Facebook leading with more than 1 billion users while Twitter service has around 290 million users.[13] *Figure 4* shows monthly users of different outlets such as a journal, a national paper and Facebook in comparison, marking a great potential.

Despite the fact that traditional news media lost blood through the “digital revolution”, smartphone users’ consumption of news has increased (Brossard, 2013). A study by Media Insight Project concluded that millennials (Generation Y) consume news through different outlets in a mix of social media, entertainment etc. instead of going to the main provider of news.[14]

2.2 Age of internet

Internet not only changed the platforms that we use to reach information, it also change the nature of it. Internet provides hypertextuality (providing links to extra information), intractability (comments, questions etc.) and multimediality (mixed type of content being present together, video, visuals, text etc.) (Brossard, 2013). These properties change the way the information is

[9] http://www.ibtimes.com/remember-newspaper-science-sections-theyre-almost-all-gone-1005680
[10] http://www.gallup.com/poll/163412/americans-main-source-news.aspx
[11] (National Science Board, 2012) & (National Science Board. 2014, p.7-16)
[12] http://www.cjr.org/currents/hard_numbers_jf2013.php
[13] http://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/
[14] http://www.americanpressinstitute.org/publications/reports/survey-research/millennials-news/

presented to and received by the readers. Whether the stories are written by journalists or scientists online, they are described as unfinished stories[15] where a back and forth conversation is made available by the initial story. Trench points out that "it (pervasive use of internet communication for internal scientific and public communication) also permits public access to 'backstage' conversations between scientists, including those that negotiate uncertainties in science. In this way, the internet helps to turn science communication 'inside-out'." (2008a, p.127).

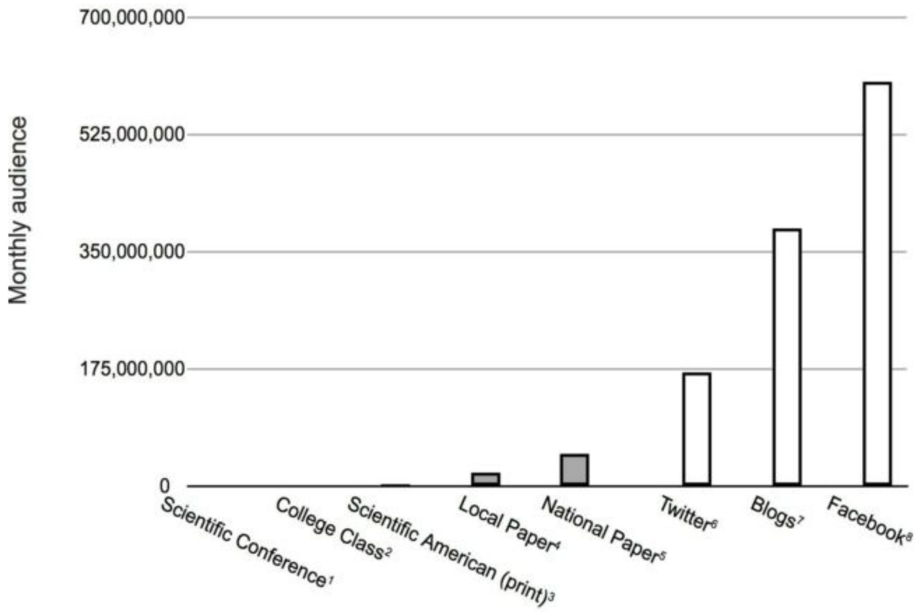

Figure 4. Monthly audience by communication methodology
(Bik and Goldstein, 2013)

Regenberg (2010, p.30), as he discusses the case of stem cell tourism communication between scientists, ethicist and the patients pursuing stem cell treatments, notes that social media is a great opportunity for all parts to get involved in an open discussion. Regenberg refers to the style of communication that is achieved by social media and internet as a "more open and egalitarian conversation" which supports the view of inside-out-science as pointed out by Trench.

This openness serves to the communication of science in various ways. Between scientists and the public, it creates a platform where direct feedback about the anticipated risks and benefits can be discussed and citizen science projects are made easy in a larger scope. In 2014, a Facebook group allowed people who were experiencing unlisted side effects from a form of birth control, to organize and, both talk to one another and talk to the officials which in this case is

[15] (Secko, Tlalka & Dunlop, 2011) and (Laslo, Baram-Tsabari & Lewenstein, 2011) as cited on (Dunwoody, 2014)

Federal Drug Administration in the US.[16] The group has more than 23 thousand members and the reports that are filed to FDA reached 2259.[17] As of September 2015, FDA called for a meeting where some members of the Facebook group will be also present.

Scientists can act as a public voice for science and, both scientists and the public can reach policymakers to create awareness for important topics such as the FDA example above. The tools available to scientists help them stay organized(lab books, citation tools etc.) and keep up with the recent developments in their fields.

2.3 Peer Communication

Between peers, internet helps to extend the communication with preprint commentaries, post-publication reviews, networking possibilities which create new collaborations. Scientists are getting in touch on social media about their ideas and some scientists even use social media getting help in their research. A great example happened when researchers at Smithsonian's National Museum of Natural History that were collecting fish specimens had to identify 5000 specimens in a short time in order to get permits to take the specimens with them back States from Guyana.[18] The team posted pictures of the specimens to Facebook and asked their peers for help and in 24 hours 90% of the specimens were identified.

There are other platforms that can be titled as scientific social networks such as ResearchGate, Mendeley, and Academia.edu. Scientists can create accounts on these platforms and follow each other's publications, ask questions, start collaborations etc.[19]

In the new era, communication of science between peers is extended. Hurd (2004) updates the Garvey/Griffith model in *Figure 5* where oval items represent the updated elements in the model. As can be seen in the figure, the communication that used to be linear is now ramified and the scientific stories are to be present in diverse platforms.

[16] http://www.wired.com/2015/09/facebook-group-got-fda-reconsider-type-birth-control/
[17] As of 21.10.2015
[18] http://smithsonianscience.si.edu/2011/03/facebook-friends-help-scientists-quickly-identify-nearly-500-fish-specimens-collected-in-guyana/
[19] See (Noorden, 2014) for a detailed account of these networks.

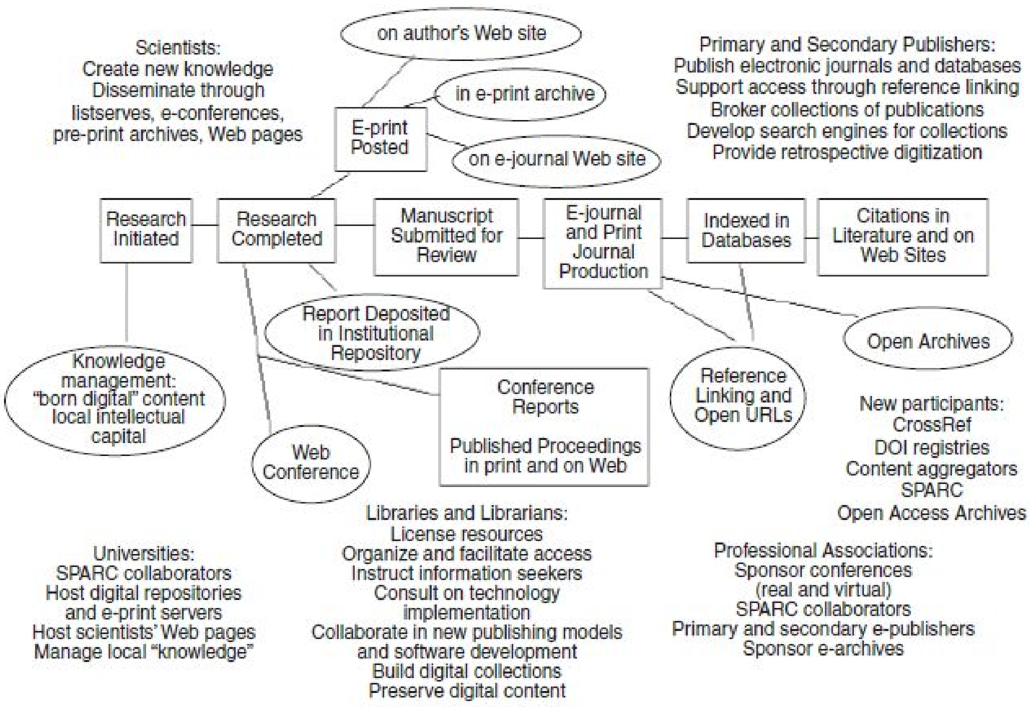

Figure 5. Scientific communication in a digital world
(Hurd, 2004)

2.4 Citizen Science

Social media does not only create a platform for openness but also carries the potential to change the way science is carried out. In the previous section, different science communication concepts are mentioned, in achieving public engagement in science there is yet another concept, citizen science. It (even though the terms is described in various ways[20]), refers to non-specialists conducting or contributing to science. Quantum Moves game[21] which is made by ScienceAtHome at Aarhus University is an example of the new generation citizen science projects that use gamification to gather data for science while players also get to learn about the science behind the game. In Quantum Moves, the player moves quantum atoms to achieve different tasks and the data about the player's movement is gathered and used in the goal of building a quantum computer. Different projects allow nonspecialists discover new antibiotic possibilities in their garden[22] or look for asteroids[23] and send their findings to scientists at NASA & Planetary Resources. Social media is also a great intermediary for creating interest in science. Citizen science projects work for this purpose as well as different scientific content going viral on social media. Bik and Goldstein (2013) mention two of such viral contents,

[20] http://www.citizensciencecenter.com/citizen-science-definition/
[21] http://scienceathome.org/
[22] http://www.wired.co.uk/news/archive/2015-09/28/citizen-science-new-antibiotics-kit
[23] http://www.topcoder.com/asteroids/asteroiddatahunter/

#iamscience[24] project which aims at collecting stories of nontraditional paths that scientists took and This is what a scientist look like project[25] which aims at changing the stereotype of scientists.

2.5 New metrics

Meho (2006) found that "as many as 50% of papers are never read by anyone other than their authors, referees, and journal editors." and "90% of papers that have been published in academic journals are never cited.".[26] The number of scientific articles is increasing every year and subsequently the metrics are being discussed. Altmetrics is a recent movement that is founded in 2010 following the fact that peer review is a slow process, very much like the citations which could come years after the publication of an article.[27] With the developing tools, calculating the impact of a paper calls for new measures, they claim (Priem et al., 2010). Altmetrics, therefore, includes mentions in social media, views, and downloads, discussions etc.

Shuai, Pepe and Bollen (2012) analyzes how scientific community reacts to newly submitted papers by looking at responses to the preprint publication of 4606 scientific articles submitted to the preprint database arXiv.org focusing on three responses: article downloads, twitter mentions, and early citation counts. Their study suggests interesting findings about the impact of social media on the fate of articles as they found a correlation between the volume of twitter mentions and both downloads and early citations. "Our results indeed indicate that the early twitter mentions of a paper seem to lead to more rapid and more intense download levels and subsequently higher citation levels" states Shuai et al. (p.6). Though, they seem cautious about drawing conclusions, they note that the correlation may be due to the fact that popular articles would receive more mentions and more citation independently of the social media impact.

Blogging scientists published blog posts that featured lists of the reasons why scientists should be present on social media.[28] One example of such bloggers is Melissa Terras who made a small analysis of her own articles.[29] She shared some of her articles in her blog, providing extra information about the research behind the papers, and some of them, she tweeted about. "The papers that were tweeted and blogged had at least more than 11 times the number of downloads than their sibling paper which was left to its own devices in the institutional repository. ". she concludes after keeping track of the download records of the papers before and after they are shared. She is also among the ones that are held back at drawing large conclusions, so she notes that the real impact of her social media efforts will be visible in the

[24] https://vimeo.com/35829872
[25] http://lookslikescience.tumblr.com/
[26] http://bit.ly/1DhKYa3
[27] The term alt(ernative)metrics is seen problematic by some scholars such as Eysenbach (2011). He states that these metrics complement the traditional metrics,not alternate them.
[28] *Science and Social Media: Some Academics Still 'Don't Get It'* http://www.scilogs.com/the-leap/some-academics-still-dont-get-social-media/ and *Why Physicist Need to Get on Twitter* http://physicsfocus.org/jude-dineley-why-physicists-need-to-get-on-twitter/
[29] http://www.scilogs.com/lindaunobel/the-verdict-is-blogging-or-tweeting-about-research-papers-worth-it/

citations, but it takes a long time to evaluate. Shuai et al., in a way, bypasses this issue by only looking at early citations. On a similar note, Eysenbach (2011) reports that “highly tweeted articles were 11 times more likely to be highly cited than less-tweeted articles”, which supports Shuai et al. and Terras.

Even though there is more to be investigated, these numbers are outstanding. Here a parallel can be drawn with European Commission’s report(2010) which stated that even though there is a lack of trust within public towards scientists, still 63% thinks that it should be the scientists that work at universities or governmental laboratories, who communicate science.

2.6 Danish Statistics

Studies mentioned above are mostly based on the States where internet access is calculated as to be 88%. West Europe follows them with 81%[30] and in Denmark the numbers are higher than the average in West Europe with 93%. Whether public space for scientists and public to interact has shifted to online environments in countries such as Denmark where the access rate to internet is really high and 2.1 million of the population of 5.5 million goes online on their mobile devices daily, where 50% of such activity consists of social media, whether scientists shows signs of such high online activity in their practices and in the dissemination of their research could yield interesting results.[31] Denmark, in general, shows high online presence in the statistics, Facebook being the online outlet with the most users, followed by Linkedin and Twitter and Denmark watches more science and technology related television and has a high science and technology readership. 54% stated that they watch science and technology related news often or very often, comparing to 47% in States. 48% stated that they often or very often read science and technology related news in the media comparing to 34% in States (National Science Board, 2014).

2.7 Chapter Conclusion

In this chapter, I summarized the shift in the information and news consumption to online channels, advantages that social media and internet provide in communicating science to the public and peer communication, new ways of public contribution to science, changing metrics in scientific publications and statistics that shows the online presence in Denmark.

I argue that shift from printed media to online channels was only the first step of changes in communicating science. Migration to social media was the second step, all news outlets not only have websites, but they are all present in social media with different accounts, as they divide the information into different segments for different target groups. Scientific accounts on social media are increasing as a part of this second step.

[30] http://wearesocial.net/blog/2015/01/digital-social-mobile-worldwide-2015/
[31] http://www.emarketer.com/Article/Over-2-Million-Daily-Mobile-Web-Users-Denmark/1010984

Bik and Goldstein (2013) suggests that online communication methods only reach people who are already interested in talking about science, au contraire, these tools and methods are changing in order to widen the reach of users. They state that it is achievable when the content goes viral, but it does not have to. When used, retweet function on Twitter allows the followers of the user who shared the content on the first place, to share it with their own network. Facebook allows users to see what the people in their network like and commented on, on their own feeds. These create what I call a **recommendation network.** We like pages, visit places, follow people that our friends on social media interacted with. As also supported by Media Insight Project study that is mentioned earlier in this chapter, millennials encounter diverse opinions and news, that they might have missed, presented to them by their networks.[32] Therefore, I argue that online channels can be used not only to reach audiences that are already interested but also they can be used to extend the reach of scientific stories following the efforts of successful accounts. One particular account on social media that is worth mentioning is *I fucking love science (IFLS)*[33] that comes up front with having more than 22 million followers. The page that is present on Facebook, Twitter, Tumblr[34], Youtube and on its own website, has the motto “The lighter side of science”. It provides recent news in science, science memes, and cartoons, pictures etc.

Despite the fact that some institutions provide basic skills for online communication, as also pointed out by Regenberg, the online presence should be considered as a continuing endeavor (2010, p.30). Social media consists of dynamic platforms which change and evolve over time and new tools will be added to the already long list in time. As Hurd (2004) presented, there is now more to do for researchers to disseminate their science than before.

I will focus on nanotechnology in order to get an understanding of the issues at play in its communication as an emerging technology.

[32] See Note 14

[33] https://www.facebook.com/IFeakingLoveScience and http://www.iflscience.com/ which appeared here in an interview on Guardian: http://www.theguardian.com/science/2013/oct/13/i-fucking-love-science-elsie-andrew

[34] Tumblr is a website that can be summarized as a mix between blogs, micro-blogging and social network. People can create sites, very much like blogs, follow other blogs and, share/publish content.

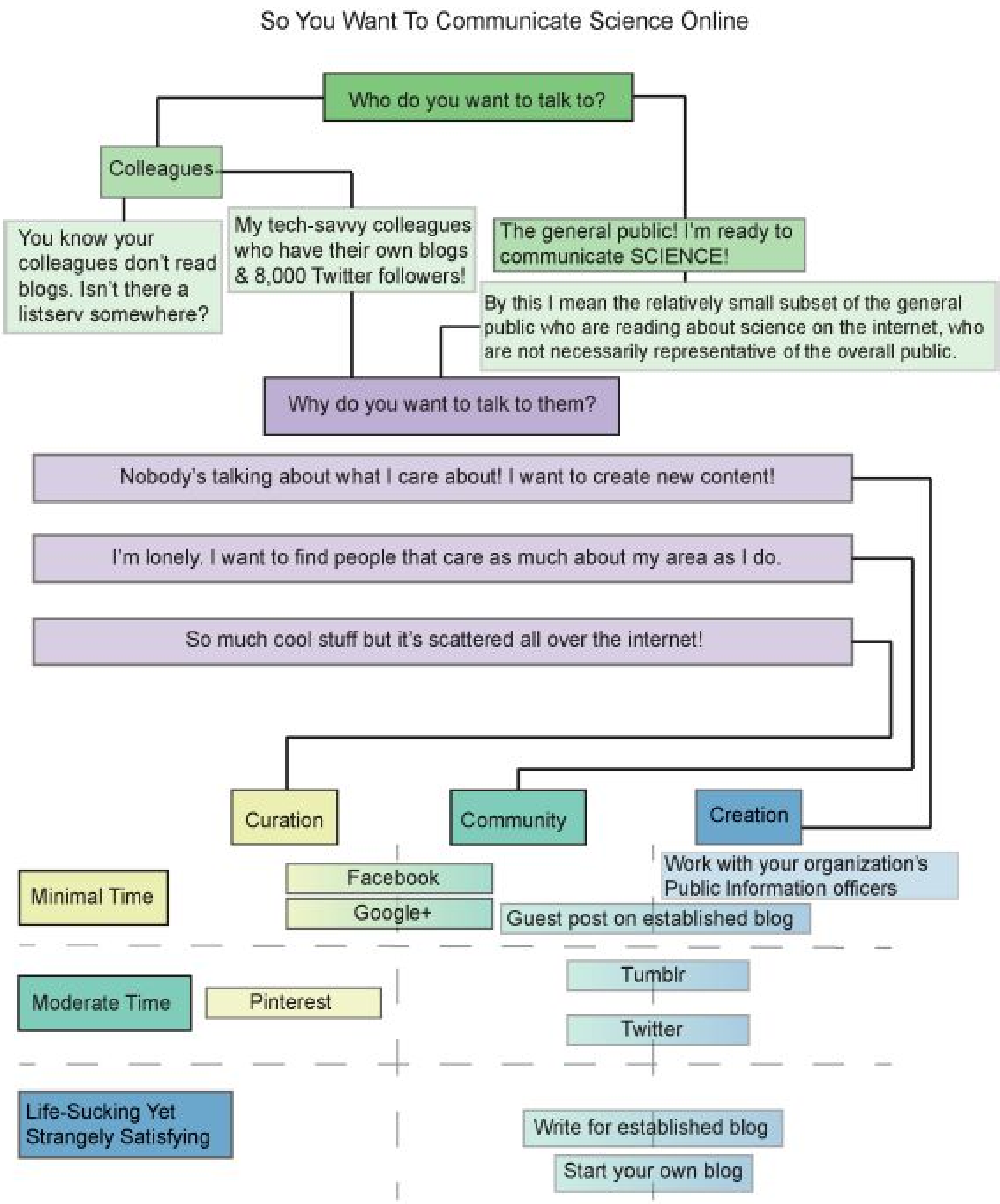

Figure 6. Flowchart showing a decision tree for scientists who are interested in communicating online (Bik and Goldstein, 2013)

3 Nanotechnology

Nanotechnology is a relatively new field, in other words, an emerging technology. Ruivenkamp and Rip (2014) counts 2000 as the beginning, the concept of design and engineering at the molecular scale, however, was first introduced by Richard Feynman in 1959 in his famous talk *There is plenty of room at the bottom*. The first use of the word nanotechnology comes later in 1974, the breakthrough, though, is with K. Eric Drexler's book Engines of Creation in 1986. The Same year also witnessed the scanning tunneling microscope "which enables us to 'see' surfaces 'atom by atom'" winning the Nobel Prize after its invention in 1981 (Hessenbruch, 2004, p.139).

Nanotechnology is a term that covers a range of topics that, with the invention and advancement of scanning probe microscopes, deals with the manipulation of matter on the nanoscale, it is able to create organic structures and mechanisms that will be put to use for various purposes. Commission of the European Communities (2005) lists water purification, providing high quality and safe nutrition, more effective delivery of vaccines, lower cost health screening, more efficient conservation and use of energy as some of its promises.[35]

Nanotechnology and the expertise that was shown by the advancement of such visualization and probing tools, certainly helped with the funds that were channeled into scientific institutions, but it has also created a blur between fact and fiction and in this blur, visions, such as Prey (novel by Michael Crichton) in which self-replicating nanorobots turns on the humanity following Grey Goo scenario(as mentioned in Engines of Creation) where such nanorobots consume all matter in the world and produce more and more of themselves, did not promote nanotechnology in the most positive way. However, Goodsell states that "lay audiences' interest in nanotechnology is spurred by fictional imagery emphasizing both hopes and fears about future nanotech developments." (Ruivenkamp and Rip, 2014, p.186). The blur can, therefore, be said to keep the players in the flow.[36]

Figure 7 shows The Hype Cycle by Gartner Consultancy exhibits the maturity, adoption and application of emerging technologies in five stages: Innovation Trigger, Peak of Inflated Expectations, Trough of Disillusionment, Slope of Enlightenment and Plateau of Productivity. There are concordances and discrepancies with the process that nanotechnology went though and the Hype Cycle. The promise of nanotechnology was spectacular then came the rationalization such as distancing from the Drexlerian vision[37] and realization that

[35] As quoted on (Nielsen, 2008, p.492)
[36] A phrase used in Game Design Theory which refers to designing games by providing adjusted difficulty and experiences which will keep the player in the game without getting bored of too much easiness or getting frustrated with difficulties.
[37] Drexler, in 2004, states that Prey "has caused a fear of a technophobic reaction to nanotechnology (Hessenbruch, 2004, p.143) and he also stated his regrets for the phrase "Gray goo" (Giles, 2004, p.591)

nanotechnology will not cure all our problems.[38] Nanotechnology as of now is climbing up on the slope of enlightenment, its applications can be encountered in a variety of businesses. Kodak is making screens with nanostructured polymer films, BASF is using polymer dispersion products in constructions etc.[39] One should keep in mind that nanotechnology covers a variety of subdisciplines and the placement of each subdiscipline on the cycle will, of course, vary.

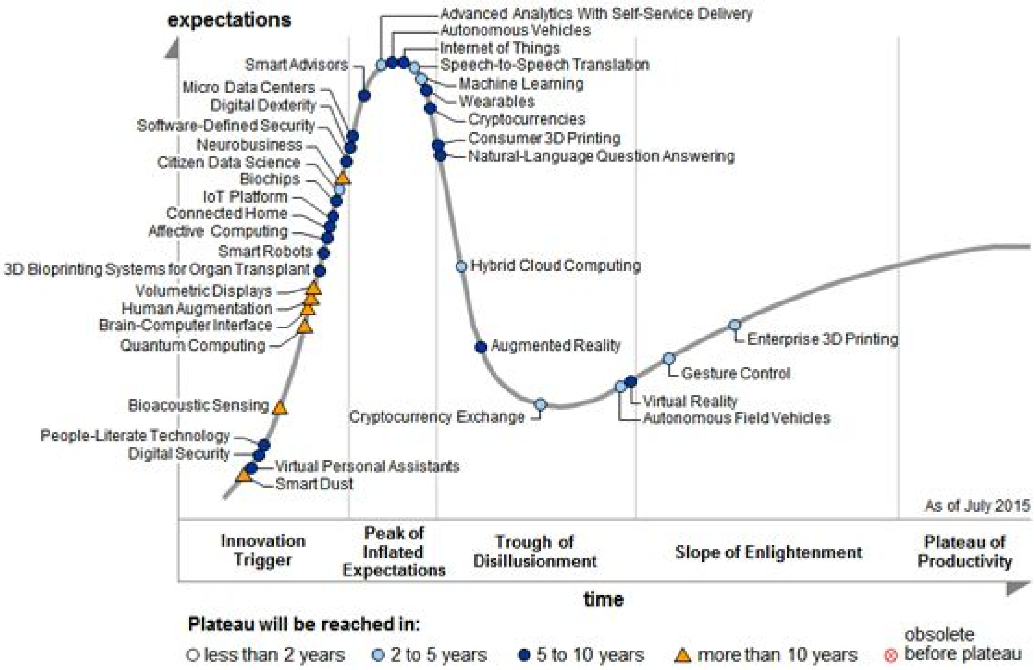

Figure 7. Gartner's Hype Cycle
(Gartner Inc., 2015)

3.1 Uncertainties

Similar to other new technologies, nanotechnology includes uncertainties both in regard to where it is leading and, to what effects it will have on the environment and on individuals life etc. creating another blur one can argue. These uncertainties together with its great potential underline the importance of public engagement in order to make it more understood, for instance, for it to not to face the same fate as genetically modified organisms (GMOs) and to seek more funding. As of now, GMO's are labeled and regulated, and with the effects of

[38] This overlaps with what Nielsen (2008) calls the *tragedy of nanotechnology.* "It (nanotechnology) will fail to bring about a Utopian society, just as nuclear technologies never put an end to war or to the world's energy problems." (p.492).
[39] For a list with more applications: http://www.nanotech-now.com/current-uses.htm and http://www.nanowerk.com/nanotechnology/reports/reportpdf/report8.pdf

campaigns by environmental organizations, they face a huge consumer rejection as they are perceived as abnormal/unnatural.[40]

Nanoparticles and nanomaterials are on the process of regulation and, there is a need for more studies in its effects to human health and the environment.[41] For instance a report issued by Royal Society and Royal Academy of Engineering in 2004, voiced concerns about the use of nanoparticles and materials in sunscreens and cosmetics and "recommended stopping this use until further research is done", yet, they also voiced support for nanotechnology in general (Friedman and Egolf, 2005, p.5,6).

Latour, in Love Your Monsters, takes the climate change issue and brings a new perspective. He states that we should not abandon our technologies on the grounds of what they may hold, we should care for them.[42] He gives the example of Frankenstein story, Frankenstein did not become a monster by its nature, it was made so later on, as he was left alone. Therefore, he states, we should care for our technologies as we do with our children. He does not think we should stop developing because of the threat of the impact of technologies, we should keep pursuing, but we should also keep them under control and care. In this perspective, the use of word Frankenstein is noteworthy not only as it serves a great deal to Latour's analogy but also for the fact that GMO opposition used the same analogy, but in a different light to refer to genetically modified food as Frankenfood. The term in that context was used to alienize genetically modified food as something that went out of control.

3.2 Public Perception Towards Nanotechnology

Nanotechnology is a very technical field for people outside of the scientific scope to get a clear understanding of. Surveys support this aspect:

> *The 2010 GSS found that 24% of U.S. respondents said they had heard "a lot" or "some" about nanotechnology, up 4 percentage points from both 2006 and 2008.* [43] *A plurality (44%) of Americans in the 2010 GSS reported having heard "nothing at all" about nanotechnology. About 37% of 2010 GSS respondents also said the benefits would outweigh the harms, 9% said the benefits and harms would be about equal, and 11% expected the harms to predominate. The remaining 43% held no opinion. (*NSB, 2014, p. 7-44 reporting on NSB, 2010)

35% of the Americans and 53% of the Europeans declared no opinion when asked about

[40] GMO's are strictly regulated, according to some. For more information see The Frankenfood Myth by Henry I. Miller
[41] See (Amenta et al., 2015) for an analysis of regulations around the globe.
[42] The essay can be accessed at http://thebreakthrough.org/index.php/journal/past-issues/issue-2/love-yourmonsters
[43] General Social Survey Survey of Graduate Students and Postdoctorates in Science and Engineering

whether they thought nanotechnology would improve their lives[44] and "the general public, especially middle school children, has no firm foundation to understand nanotechnology and likely will continue to be equally impressed by credible scientific information as well as pure fictional accounts of nanotechnology." (Gaskell, 2005; Waldron, Spencer and Batt, 2006, p.569). In addition, the survey Scheufele and Lewenstein (2005) carried out shows "55% of all respondents who indicated that they were aware of the issue of nanotechnology expressed overall support for nanotech, compared to only 28% support in the unaware group." (p.663)

The numbers above underline the fact that citizens are uninformed about nanoscience, and their support increases among the more informed segment. There is an audience, though not dominant, thinks that nanotechnology would bring more harm than benefit.

According to Scheufele and Lewenstein (2005) the fact that most are unaware of nanotechnology "does not mean that they do not make decisions or judgments about it. Rather, their opinions will be influenced by factors other than information, such as ideological predispositions (the way mass media frame issues, or their levels of general scientific literacy" (p.661). They summarize the cognitive miser theory which "suggests that people are 'cognitive misers' or 'satisficers' who will only collect as much or as little information about a given issue as they think is necessary to make a decision."[45] On the contrary, scientific literacy theory rests on the public deficit model which then rests on the idea that public lacks the necessary knowledge to make better decisions.

Popkin (1994) argues that citizens have to put a lot of effort into understanding the complex issues or issues about complex topics, such as nanotechnology and the reward of making better(informed) decisions might not be enough and, therefore, it makes sense for them to rely on already informed groups(regulatory bodies, interest groups, media etc.) He refers to this phenomenon as "low-information rationality".[46] As mentioned in the first chapter, citizens rely on previous experiences, cultural context, and personal circumstances to process information and similarly their decisions are also affected by these and "heuristics or cognitive shortcuts", such as ideologies, beliefs and media (Fiske & Taylor, 1991).[47] Medin and Bang (2014) mention "epistemological orientations" which refer to the way of seeing and perceiving the world around us which are culturally dependent. These phenomena emphasize that science communication should take cultural considerations into account.

3.2.1 Circle of Mass Communication and Media Portrayal

Both low-information reality and cognitive miser theory support Friedman and Egolf (2005), that public becoming more involved is dependent on the appearance of nanotechnology

[44] As quoted on (Friedman & Egolf, 2005)
[45] Satisficing is a term constructed from satisfy and suffice by Herbert A. Simon. For more see: (Simon, 1979). Summarizing (Fiske & Taylor, 1991) **and** (Popkin, 1994) **and** (Kunreuther, 2001)
[46] As quoted on (Scheufele & Lewenstein, 2005)
[47] As quoted on (Scheufele & Lewenstein, 2005)

on mass media and the world wide web. Miller (1999) frames the process of scientific issues in the media in "circuit of mass communication". As can be seen in *Figure 8* there are four sets of actors that communicate with each other and at the same time there is a loop that represents a general communication between actors.

Different studies investigated how nanotechnology has been portrayed in the mass media. Lewenstein, Gorss and Radin (2005) in the US and Kjærgaard (2010) in Denmark showed that the portrayal was positive while in the UK the portrayal (Friedman and Egolf, 2005) was less positive than in the US, as a result of some key stories that made it to the newspapers such as Royal Society's report and Prince Charles' comment on the gray goo scenario, as it can be argued. [48]

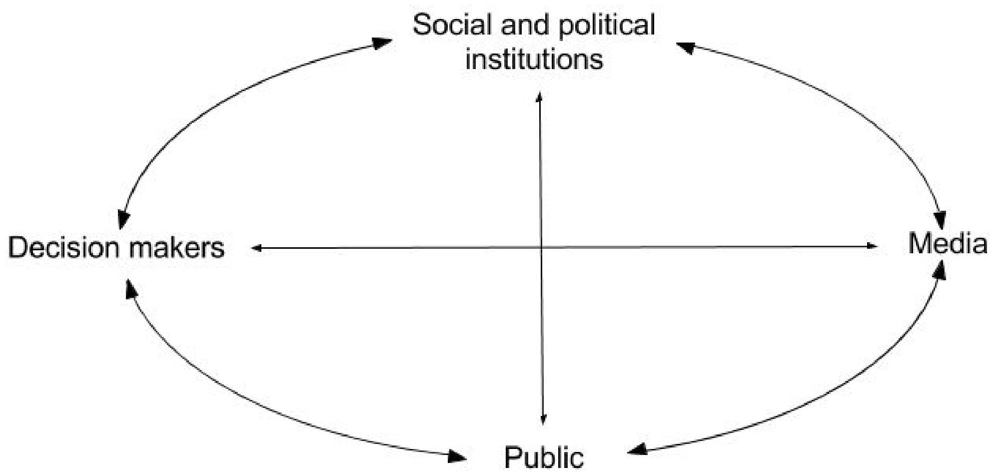

Figure 8. Circle of mass communication
(Miller, 1999)

3.2.2 Images of Nanotechnology

Science is, in some cases, delivered to public through imagery, let it be pretty pictures[49] that are constructed for popular science or be powerful images that travel outside of the scientific scope. The power of images can be used to reinforce or disempower some narratives (Burri and Dumit, 2008). In the case of nanotechnology, we have images such as Nanolouse (see *Figure 9*) that media held on to even after the discipline went away from the doctrines that the image represented. Nanolouse represented future visions, great accomplishments, fictive applications, danger, and threat, all at once, all at different times.[50]

Ridder-Vignone (2012) and, Ridder-Vignone and Lynch (2012) investigate the importance of

[48] independent.co.uk/news/uk/this-britain/prince-warns-against-new-thalidomide-disaster-552784.html
[49] A term that Lynch and Edgerton (1988) use for pictures produced for the public. These pictures are manipulated.
[50] See (Landau et al., 2009) for a study of how certain images affects what people associate with nanotechnology.

images and image galleries in achieving a public understanding/engagement of nanotechnology. As nanotechnology is a complex and technical subject with various sub-disciplines, they suggest that public does not need to know all the facts and their claim is that art galleries could achieve such understanding via images.

The Materials Research Society believes that science must perform as art, invoke the same feel in the audience, in order to be presented to nonscientific audiences (Ridder-Vignone, 2012, p.435) and Cris Orfescu, an artist and a scientist who organizes NanoArt21 annual exhibition, states artists should familiarize the general public with the nano universe, so people will focus on the positive effects and redirect the negative ones to benefit from them (Ridder-Vignone, 2012, p.436).

Ridder-Vignone (2012) writes that these exhibitions can engage the public in a way that they have a say in what this new technology's identity will evolve into and these images are what Kaiser refers to when he "future visions constitute future worlds in ours".[51] Images represent expectations and expectations drive disciplines. If the public is involved in the expectations that the images represent, it can be argued that they will engage in the science and what it has to say as well.

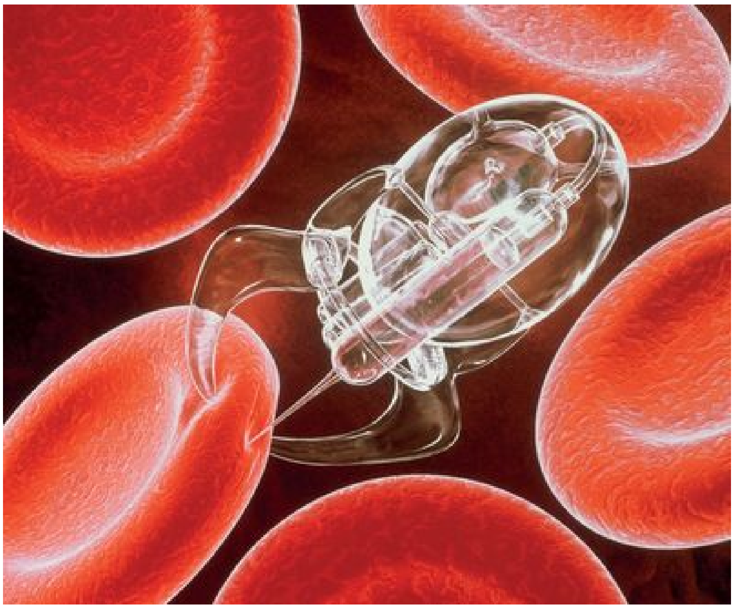

Figure 9. The Nano-louse.
It won the first prize in the Science Concept section of the 2002 Visions of Science Award and later was used widely across platforms.
Produced by Coneyl Jay.

[51] As quoted on (Ridder-Vignone, 2012, p.433)

3.2.3 Knowledge Gap and Internet

Knowledge gap concept rests on the idea that higher socioeconomic segment in a society will reach and use the information faster than the lower socioeconomic segment as opposed to the idea that the information available through mass media will result in a more equally informed public.[52]

Previously stated statistics already presented us that the public is not informed about nanotechnology, Corley and Scheufele (2010) points out that between 2004 and 2007 the knowledge gap between the most and the least educated citizens widened in terms of their nanotechnology knowledge (see *Figure 10*). As the group who is already interested in nanotechnology is getting more and more informed, there is a decrease observed in the low education segment. In their analysis lays another interesting finding, the number of days a week that people spent online was significantly related to their knowledge about nanotechnology, the low educated segment was "catching up with their educated counterparts" (p.22) (see *Figure 11*).

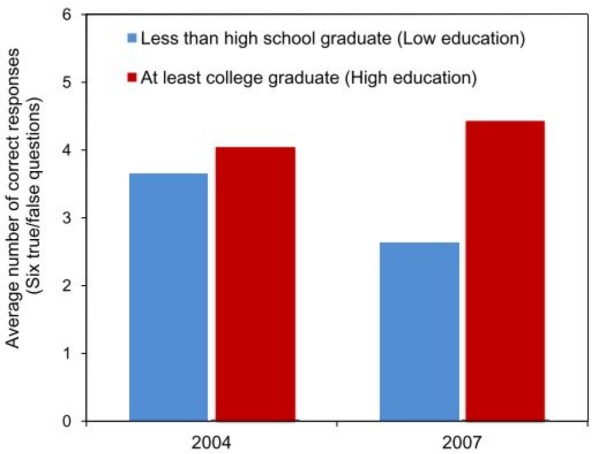

Figure 10. Widening knowledge gaps about nanotechnology
(Corley and Scheufele, 2010)

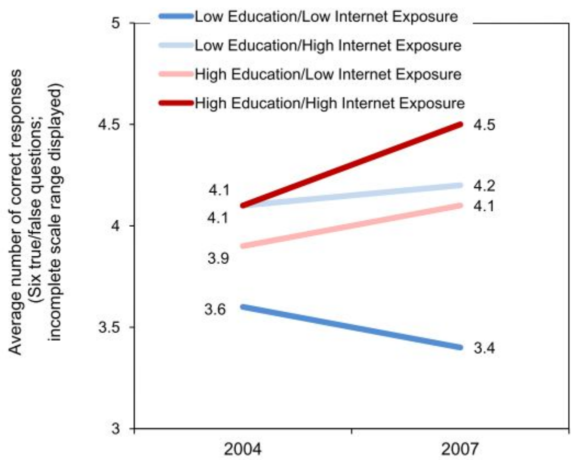

Figure 11.[53]: Exploring knowledge gaps about nanotechnology across education level and internet exposure (Corley and Scheufele, 2010)

Cacciatore, Scheufele and Corley (2014) takes this study further and compares the internet and tv use. *Figure 12* shows first that each group despite the internet use, there is an increase in knowledge levels. Low education/high internet segment shows a similar pattern and similar knowledge level to high education/low internet segment. In low education group, high internet

[52] A rewrite on " As the infusion of mass media information into a social system increases, segments of the population with higher socioeconomic status tend to acquire this information at a faster rate than lower status segments, so that the gap in knowledge between these segments tends to increase rather than decrease" (Tichenor, Donohue & Olien,1970, p.159-160) as quoted on (Cacciatore et al., 2014 p.378)
[53] Figure available in the preprint version of (Corley & Scheufele, 2010)

users start out with a higher level of knowledge which continues to increase. Internet usage is therefore linked to reducing nanotechnology knowledge gap across different education levels.

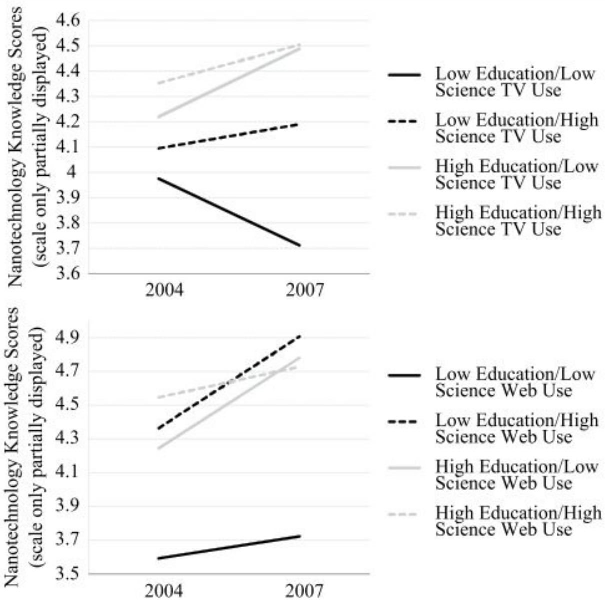

Figure 12. The three-way interactions between Year, Education and Science TV use and Year, Education and Science web use on nanotechnology knowledge score (Cacciatore et al., 2014)

3.3 Chapter Conclusion

In this chapter, I outlined some uncertainties and their importance in communicating nanotechnology to the public. Statistics showed that public is generally unaware of nanotechnology and, therefore, hesitant in agreeing that it will better our lives. Then I gave some accounts that suggested that lack of awareness on nanotechnology does not stop public from forming opinions about it. Public, instead, relies on already informed groups such as policy makers and the media in addition to what they already rely on making everyday decisions such as their beliefs, habits, previous encounters with similar issues, hence underlining the importance of media portrayal(framing) of nanotechnology. Afterwards, the circuit of mass communication was exhibited in which all four actors(public, media, policy makers, and institutions) influence one another. I followed the chapter with a different approach to communicating nanotechnology, images. Some scholars looked into how images and image galleries can involve the public in nanotechnology because nanotechnology is technical and complex, they suggest that public does not need to know all the facts in order to be involved and in order to get a sense of it. Lastly, knowledge gap in nanotechnology between high education and low education segment was shown to be increasing however, internet usage was identified as a factor that helped low education segment to catch up with the high education segment.

For nanotechnology not to face similar challenges as GMOs, there is a need for continuous public involvement. As of now, the biggest challenge for communicating nanotechnology is to make it known after all nanoworld, in a nutshell, is a place of unknown. How issues are framed is important to opinion forming but Druckman and Bolsen (2011) found that in conveying nanotechnology(carbon tubes to be precise) and genetically modified foods, the factual information did not have a greater impact than background factors. This nullifies the notion of the better informed public will make better decisions which was, among others, the basis of the deficit model.

This, of course, is not to underestimate the fact that people are unaware of nanotechnology. The knowledge deficit can either be seen as an obstacle in achieving a "healthy" conversation with the public or an opportunity to build one. Participation of the scientists themselves in this conversation will be a great contribution. For science to spread out, scientists have to be more involved in the public conversation.

4 Problem Formulation

4.1 Base study

Dudo et al.(2014) in the October issue of 2014 in Nature Nanotechnology reports on their survey that investigated nanoscientists' participation in public communication. Divided into two goals, the study was about analyzing the *self-reported propensity to communicate with lay audiences and to identify the predictors of nanoscientists' willingness to engage in public communication activities*. For the survey, 216 nanoscientists affiliated with the National Science Foundation's (NSF) National Nanotechnology Infrastructure Network (NNIN) answered questions in terms of their communication with lay audiences and media professionals between 2008 - 2013.

The survey showed that nanoscientists are currently involved in public engagement activities. Around 80% stated that they had participated in one or more public communication activity, and around 50% indicated that they had participated in four or more activities over the five-year period (see *Figure 13*). 75% of the nanoscientists agreed that their public communication efforts have had a positive impact on them professionally and 58% stated the same about their communication with media professionals (see *Figure 14*).

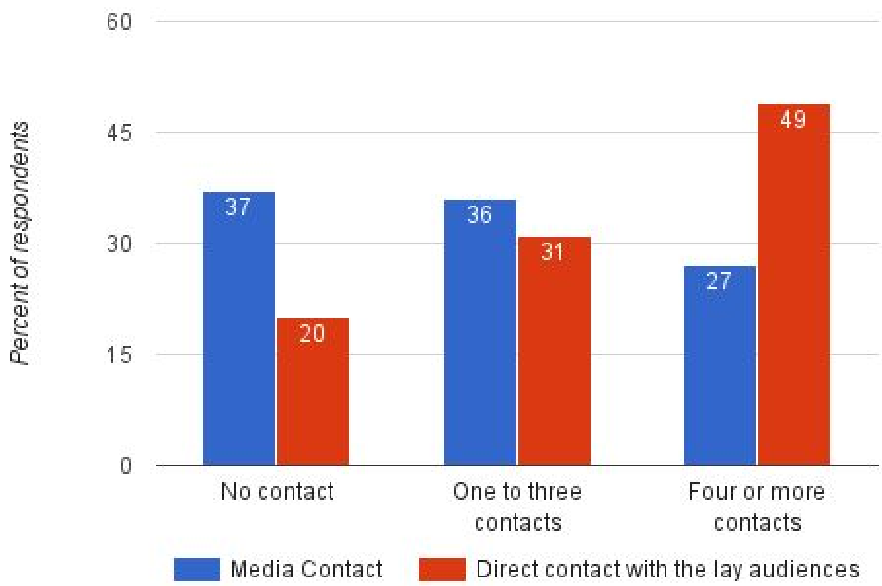

Figure 13. The amount of contact American nanoscientists reported with media and lay audiences in 2008-2013. *N= 216 and 214 respectively.* (Dudo et al., 2014)

Nanoscientists who regarded public communication as important for the welfare of society were more likely to intend to engage in mediated and direct public communication activities and the ones who perceived professional benefits from generating publicity about their research were more willing to participate in direct and mediated public communication. Scientists who spend more time using online tools (for example, microblogs, social networks, forums) to communicate about science were more likely to express a willingness to participate in public communication through media professionals.

Cacciatore (2014) underlines the fact that science is becoming more politicized and this in return, together with the recent cuts in funding underlines the need for public communication in a cost-effective manner, this could imply that scientists must take more responsibility in communicating their science to nonspecialists.[54] Dudo et al.'s survey shows that nanoscientists in the US are already taking that extra responsibility.

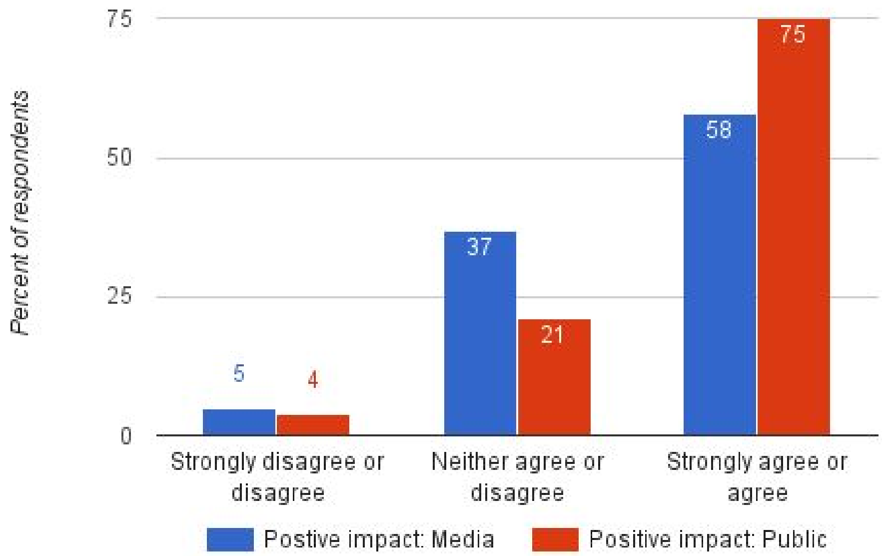

Figure 14. Nanoscientist' evaluations of the professional impacts of their contact with media professionals and direct public engagement efforts. *N=134* (Dudo et al., 2014)

4.2 Research Questions

Online communication is becoming more ubiquitous and potentially useful to science communication as outlined by chapters 1, 2 and 3. Nanoscientists need to be able to

[54] $39.2 million in 2007 to $36.1 million in 2010. Though the funding for nanotechnology in total was increased.

communicate their results in order to keep the public interested and positively inclined towards nanotechnology as also expected to do so by the public, therefore, it is interesting to look at to what extent and how nanoscientists use online tools. Science communication depends on the national context because our epistemological processes depend on the culture, even though science functions on universal criteria, how it is carried out in practice and how it is perceived is culturally dependent. Thus, it is interesting to investigate national differences. Furthermore, as mentioned in chapter 1, the relationship between scientists and media professionals is interesting to study, in the changing conditions that the online revolution brought upon.

This study, therefore, focuses on The Interdisciplinary Nanoscience Center (iNano)[55] at Aarhus University in Denmark and surveys nanoscientists affiliated with the center as a starting point. Aarhus University is among the three universities in Denmark which offers both bachelor's and master's degree in nanoscience. If successful, this study can be extended to other two nanoscience research communities in Denmark.

Following questions is investigated in this study:

To what extent do nanoscientists at iNano use online tools?
To what extent does this usage relate to their scientific work?
What are the similarities and differences between Danish and American nanoscientists in terms of their communication activities?
Are scientists bypassing media professionals in communicating their science?

Results of the study, apart from reaching an understanding of how communication between nanoscientists and lay people, media, and their peers is carried out, is to determine whether there is a need or a place for improvement in such activities. Therefore, the results from this study can be used to enhance scientific communication that is carried out by scientists themselves in the age of information and hopefully to provide guidelines for such enhancement.

[55] http://inano.au.dk/

5 Methodology

In order to answer the research questions, a two-step study is constructed. This study involves a survey which is followed by interviews. The survey forms the majority of the empirical work done for this study and interviews provide interesting nuances.

5.1 Survey

The survey consists of three sections which are complementary: Dudo et al. (2014)'s survey forms the basis and first 21 questions are from their study investigating public communication behavior of the nanoscientists, their online activities, and use of online tools. Following 5 questions investigate online publication drives and, online publication and sharing frequency following Letierce, Passant, Decker and Breslin (2009). Last 5 questions investigate the timing of publications and sharing activities, promotion of scientific activities and attitude towards connecting peers on social media. For a list of all questions in the survey, see **Appendix A**. For a list of the scales that are used in the questions, see **Appendix B.**

SurveyXact is used as the survey platform because it is provided by Aarhus University with campus license, meaning that the platform is free of charge for students and staff at Aarhus University.[56]

A paging layout, where the respondent has to click *Next* to proceed to the next question, is used, which is suggested by Couper (2008) for lengthy surveys. This allows collecting data from uncompleted surveys as well as enabling easy handling for conditional questions which are only displayed if certain answers were chosen in previous questions. Design, for the most part, follows the tips given by Thomas (2004) for an increased response rate. Distribution emails are personalized with the name of the respondents, the survey is designed with a light background with dark lettering, instructions are made clear with different colored navigation buttons and readable fonts. Introduction to the survey and the cover in the emails are shortened for the follow-up reminders.

Information about 410 staff members that are affiliated with iNano Center were retrieved from the official iNano website and is used in the survey platform as background variables. People were removed from the list because they were either students(9), exchange students(7) or technicians(5). 9 people were no longer associated with iNano and one scientist was on maternity leave. Distribution e-mail could not be delivered to 23 recipients because some email addresses no longer existed(18), some email addresses could not be found on the server(4) and one has moved to another department/job. All in all, leaving **356** potential respondents in the effective sample after the deletion of the invalid recipients.

[56] http://www.surveyxact.dk/

The survey was distributed on 28.09.2015 (on a Monday), giving respondents two weeks to respond. After two weeks, paper notices that reminded the survey were placed in scientists' postboxes and on the same day reminder e-mails were sent, giving them an extra week to complete the survey. After the overall three weeks period, respondents, who till up to that point partially completed the survey, were sent a reminder to complete their surveys. The survey was, in total, open for responses for 4 weeks.

Analysis of the survey benefits from the methodology that is used in Dudo et al. (2014). They focus on behavioral intentions in predicting actual behavior following Armitage and Conner(2011) and Ouellette and Wood (1998). As not all questions from their survey are used in this study, there occur differences in the number of independent variables. These questions were taken out as a result of the intention of keeping the survey at a certain length and the focus of the study. Therefore, a direct comparison can not be made but the overlapping points are discussed in the next chapter.

The analysis of the relationship between dependent and independent variables are as follows. Two questions that measure the willingness of mediated engagement are multiplied in order to get one dependent variable. This was possible as the two variables are correlated and they were equally weighed in this setting. Afterwards, a hierarchical multiple regression is used. This model allows dividing the data into separate blocks and analyzes the differences in the variances of each block hierarchically. The blocks, in this case, are control variables, media consumption and use, planned behavior and media orientations. For each block changes in the R^2 (incremental R^2) which is interpreted as the percentage for the variance in the dependent variable that is caused by the independent variables in that block after the effects of the previous model are extracted, is to be calculated. However, as will be mentioned in the next chapter, the response rate in this study is an obstacle in getting meaningful data in incremental R^2 and, therefore, it will be omitted.

Generally, the relation between the variables is given with their adjusted R^2 values and the statistically significant data is marked. The same procedure is repeated for the direct engagement, resulting in *Table 4*.

The questions besides the ones based on Dudo et al. (2014) are not included in the regression analysis mentioned above. Their results are presented and discussed in the next chapter separately.

5.2 Interviews

Subjects were contacted after the survey analysis was done. Interviews were planned as semi-structured and carried out in a journalistic manner. A list of questions was prepared based on the background of the subjects and their answers to the survey. The number of questions was kept to a minimum to allow the conversation to grow depending on the answers of the subjects. For the full list of prepared questions, see **Appendix C**.

Before the interviews, subjects signed a consent form. Interviews lasted between 25 and 35 minutes and were audiotaped and transcribed afterwards. Each subject is numbered as S*n* and their descriptions can be found in **Appendix D**. The information that is given within the brackets in the quotations is to summarize a long content, to specify the referrals etc. Bold parts indicate the questions asked by the interviewer. Ellipses are used for expressing that there is omitted content in the flow. No matter the gender of the subjects, female reference is used.

Two scientists that presented low online activity in the survey are chosen for the interview among the one that stated their willingness for a follow-up interview.

6 Survey Results

6.1 Response Rate

Response rate in this survey varies between 10.4% and 13.2%. In addition to 37 completed surveys out of 356, 10 partially completed surveys were also calculated in the analysis of the questions, causing the variation. For each question, the number of people in the sample will be given in the figures. *Figure 15* shows the comparison between the general sample, the completed and all responses(complete and partials).

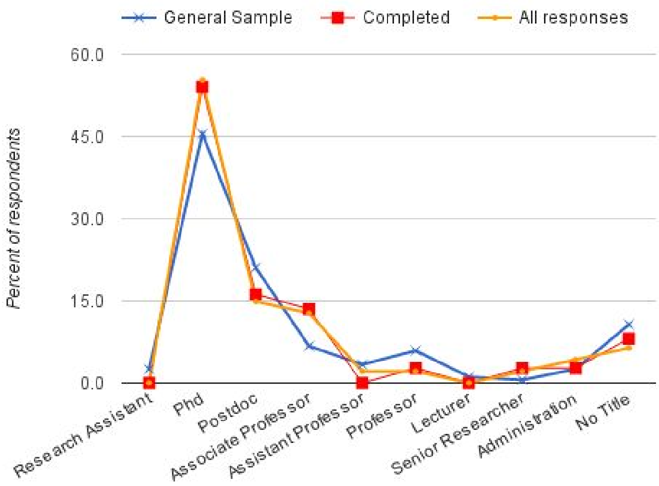

Figure 15. Comparison between the general sample, completed surveys and all responses in terms of job titles

Cook, Heath and Thompson (2000) found an average of 39.6% web response rate among 49 studies they investigated.[57] Dudo et al. (2014) report 25% response rate in their survey which is the base for this study.

Even though high response rate is generally considered more representative, there is evidence that suggests otherwise. Visser, Krosnick, Marquette and Curtin (1996), in defense of mail surveys that received 10-20 % responses which proved to yield more accurate results, states that “to view a high response rate as a necessary condition for accuracy is not necessarily sensible, nor is the notion that a low response rate necessarily means low accuracy.” (p. 216) In their study of random digit dialing surveys, Holbrook, Krosnick and Pfent (2007) discovered that lower response rates decrease representativeness “though not much” and they claim that this “challenges the assumption that response rates are a key indicator of survey data quality.” (p. 528)

[57] As quoted on (Thomas, 2004, p.124)

The survey in this study can be counted as "long" following on Rosenblum (2001) which suggests 20 questions for online surveys, however, Deutskens, De Ruyter, Wetzels and Oosterveld (2004) found in their study that "the length of the questionnaire did not have a negative effect on the quality of responses" (p.33). but one has to keep in mind that their survey included different forms of incentives. Deutskens et al. also notes that partially completed rates were slightly higher in the long surveys in their comparison. The results of such comparisons should be applied cautiously as the different samples have different motivations and connections for the subject of study.

Despite the fact that there exists research that suggests low response rate does not necessarily imply a non-representative result, the data should be read with caution. Therefore, the analysis of the data gathered in this survey should be seen as considerations.

6.2 Results

6.2.1 Contact with Media and the Public

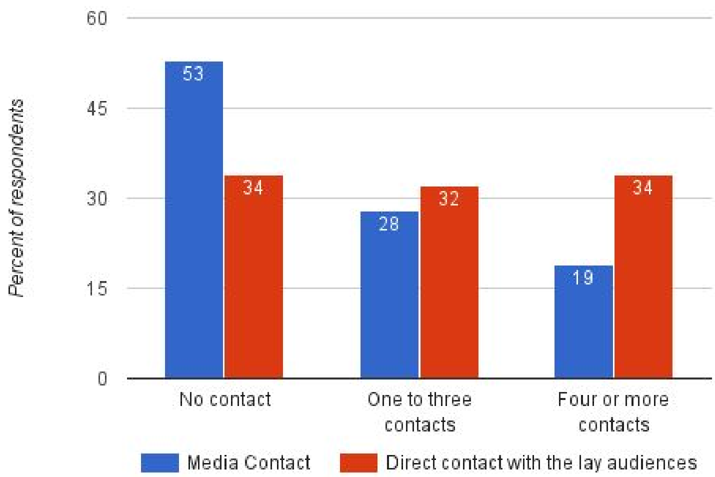

Figure 16. The amount of contact Danish nanoscientists reported with media and lay audiences in the past five years. *N= 47*

Danish nanoscientists report less contact with media and the public than their American peers. 66% stated that they had one or more contact with the public, for American nanoscientists, the number was 80%. 34% in the Danish sample reported having four or more contact with public over the course of the last five years, in comparison to 49% for American nanoscientists (see *Figure 16* and *Figure 13* for comparison). 47% stated that they had one or more contact with the media in the past five years in comparison to 63% for their American peers. 19% of Danish nanoscientists had four or more contact with the media in the last five years which is 8 points lower than American nanoscientists.

The majority (67%) of the sample reported not receiving formal communication training while American sample were more evenly distributed with 49% not having received such training. 15% among the scientist who received communication training reported that the training was intended to help reach media professionals more effectively in comparison to 4.2% in the American sample. General Public and Students were the leading with 31% followed by Scientists with 15% (see *Table 2).*

Table 2. Target audience for communication training

	Percentages
Students	31%
Scientists	15%
General Public	31%
Politicians / Policy Makers	4%
Funding Sources	4%
Media Professionals	15%

As can be seen from *Figure 17*, Danish nanoscientists reported less agreement with the statement that contact with the media and the public had a positive impact on them professionally with 35% and 46% respectively in comparison to *Figure 14*. Danish sample also reported more skeptic position in this regard with almost half of the sample neither agreeing nor disagreeing with the statement.

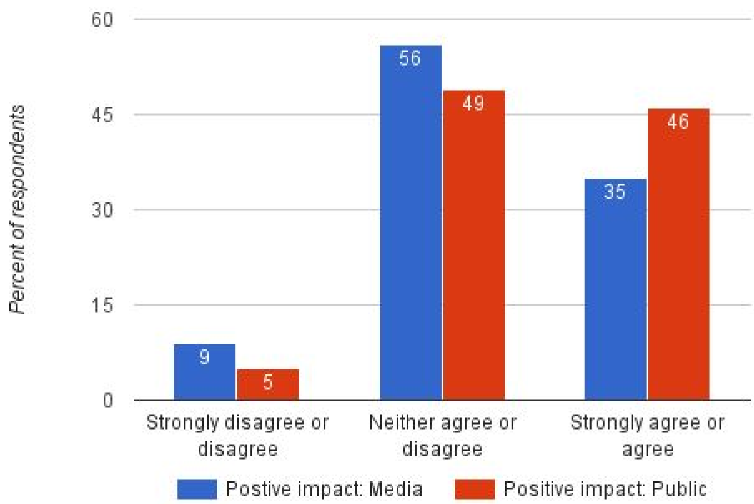

Figure 17. Danish Sample: Professional impact of contact with media and lay audiences. *N=43*

6.2.2 Online Behaviour

There is a stable group of 27% *never* shares/posts content online (see *Table 3*). 35% of Danish nanoscientists *sometimes* post academic content online. One can see that scientists *usually* and *always* post more non-academic content than academic content and 30% *sometimes* share content from others.

Table 3. Frequency of sharing/posting content online

	Academic content	Non-academic content	Sharing content from others
Never	27%	**27%**	27%
Rarely	22%	24%	27%
Sometimes	**35%**	16%	**30%**
Usually	11%	22%	11%
Always	5%	11%	5%

N= 37

8% states that their online activities are a result of compulsory reasons, 73% agreed that they share/post content online because they want to share their knowledge while the online activities of 27% of the scientists were to communicate about venues (see *Figure 18*). 16% reported reasons other than the given choices such as:

- "To increase awareness about our work and thus increase impact"
- "Questions from non-scientists sometimes bring a new and interesting perspective on ongoing research, because engaging the public(especially high school pupils in my case) is fun and informative both for them and for myself."

One scientist pointed out the in-house wiki system that iNano is using which functions as both a lab book and an organizer and that some scientists use this system daily apart from online tools mentioned in the survey.

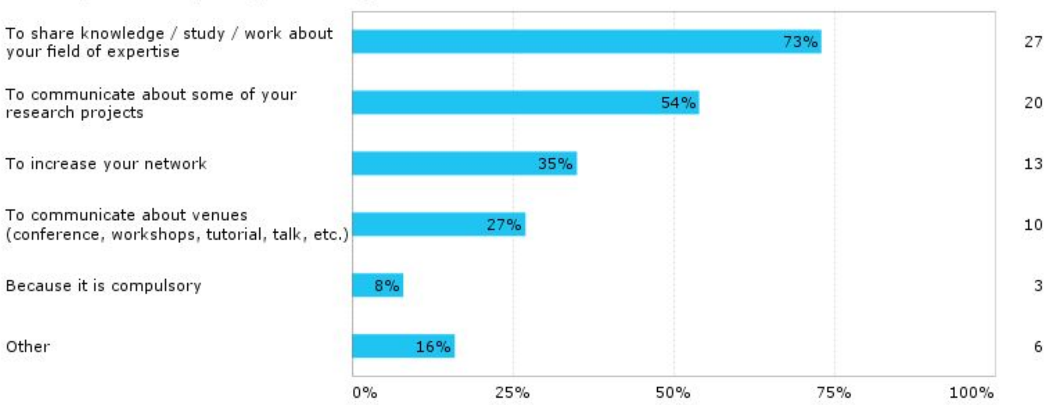

Figure 18. Reasons for sharing and posting material online. *N=37*

When it comes to the timing of the publications, 62% uses online tools after publication to promote their papers, this aspect will be investigated later. When there is an interesting finding in their fields, 59% stated that they would post about that finding. 30% reported that they would share the papers of their coworkers as well. Some scientist stated that they would also share the findings in fields other than theirs when there is an innovation and as stated above some scientists stated that they use their wiki system to continuously post about their ongoing research (see *Figure 19*).

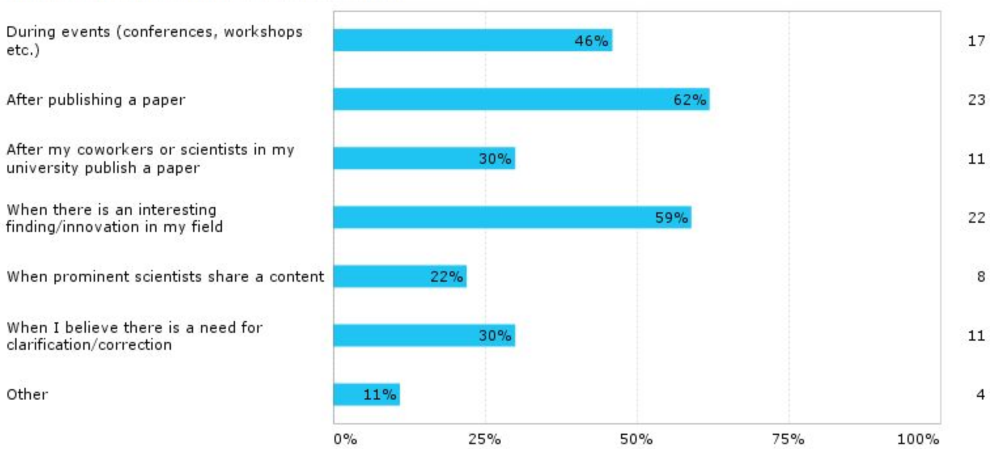

Figure 19. The timing of sharing/posting academic content online. *N=37*

Despite the fact that 73% states that they share content online, 65% states that they aim to reach their peers through their online activities while 54% states the same about the general public. This shows that nanoscientists are communicating more with their peers than the general public which could be seen as a reason for the relatively low contact with the media and the public in the previous section. 76% of the sample stated that they follow their peers on social media which supports the idea that scientists are using such tools to be in touch with their peers.

When asked, the scientists that are not following their peers on social media stated the following reasons(answers reconstructed as full sentences):

- “Social media is information pollution.”
- “I do not think the use of social media benefits the progression of the society in the right way.”
- “I have just started my PhD, so I have not had the time yet, but I will be using Linkedin.”
- “I do not have a Twitter or Facebook account, instead I use Feedly[58] to find relevant papers. I believe scientists who use social media are doing so to promote themselves and the content is not great either. I would rather find about it independently.”

[58] Feedly is an application that gathers the news from various sources that the user picked. Feedly was not listed in the survey as an option.

- "I do not have time for it."

These responses yield two issues. First is the lack of time, in between research and teaching scientists might have to struggle to create time for online activities. Second is the negative attitude towards social media with reasons relating to the quality of the information available online and/or disapproval of social media culture.

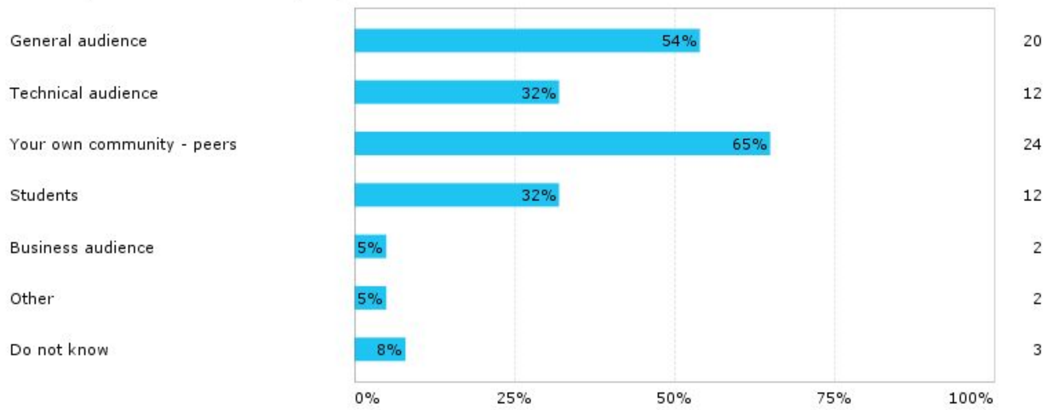

Figure 20. Intended audience when publishing and sharing material online. *N=37*

Figure 21 below shows the online preferences of scientists in three categories. In general, scientists use these tools to get news about science more than to communicate science or to promote their publications but overall, the numbers are low, indicating that these tools are not a part of scientists' daily practices.

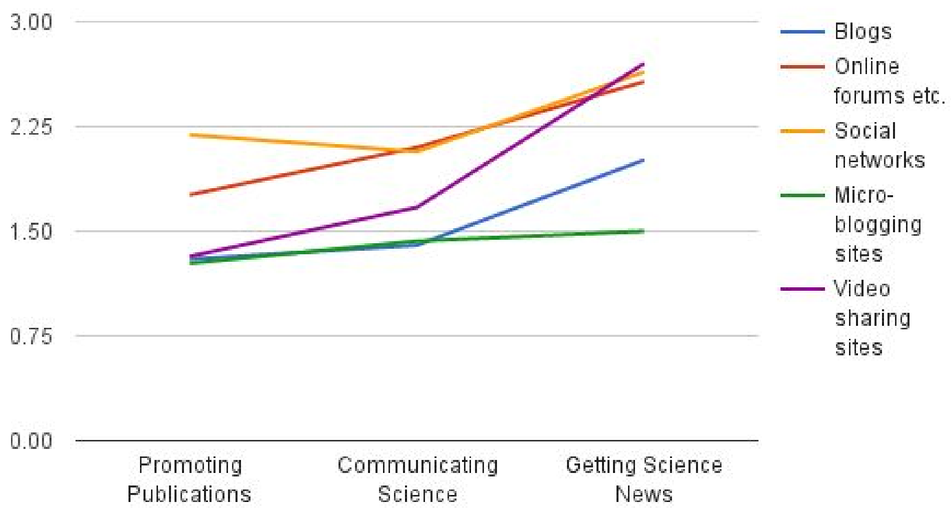

Figure 21. Use of online tools for promoting publications, communicating science and getting scientific news. (1-5 scale, mean values are plotted.)

6.2.3 Nanoscientists' Intention to Engage in Public Communication

The analysis suggests that nanoscientists who previously engaged with media were more likely to engage with media in the future as well. There is also a relationship between use of online tools and willingness of engagement with both media and the public. The nanoscientists who use online tools to get scientific news were also likely to engage in direct communication activities with the public.

Nanoscientists' intentions to engage with the public is related to their enjoyment in communicating their science. Similarly, nanoscientists who regarded communicating science important for the society were likely to engage with the public. Nanoscientists who regarded public reputation important were likely to engage with the public more than their peers.

Table 4. Predicting nanoscientists' intention to engage in public communication

		Engagement with media	Direct engagement
Control variables	Gender	0.034	-0.012
	Status	-0.018	0.005
	Previous behaviour (context specific)	**0.142****	0.023
Media consumption and use	Consumption of online-only media for science news	-0.037	**0.156***
	Consumption of traditional media for science news	0.074	0.028
	Use of online tools to communicate about science	**0.173***	**0.255****
	Use of traditional media to communicate about science	-0.044	-0.006
Theory of planned behavior	Communication self-efficacy	0.074	0.001
	Communication training	0.011	-0.027
	Personal enjoyment	0.084	**0.267***
	Importance for society	0.169	**0.278***
	Negative external norms	-0.047	0.083
	Positive external norms	0.035	**0.149***
Media orientations	Presumed media influence	**0.24***	0.139
	Media motivations	**0.132***	0.008

*$p<0.05$, **$p<0.01$

7 Interviews

7.1 Explaining Research

During the interviews, when asked whether it is difficult to explain what they do in their projects, two things came to the surface. First is the use of visuals in explaining their science to people outside of their scientific field. S2 reported using visuals (images and animations) to explain her research. Second is relating their science to objects or concepts people already know. In S1's case, working with DNA helps to explain the research because it is a structure people either heard or know of. It may get difficult for people to comprehend structures smaller than that. S2 gave a comparison of two projects that her friends were working on. In that example, once again, projects that aim at developing structures that people relate to, such as glue, are easier to explain.

S2: *"It (explaining what I do) was difficult until my PhD. When I started to do my PhD, suddenly it became quite easy to explain, because, when you are making these small devices using DNA nanotechnology, it is actually quite visual. And you can make animations to show how the device works. So that kinda made it easy to explain."*
S1: *"I think it is difficult to explain. I think I am quite lucky compared to others because I work with DNA and a lot of people know what DNA is. But then I have to dive into the parts that DNA consists of and then it gets more difficult to explain."*
S2: *"For example, she was developing a glue for putting together wounds. And glue is easy to explain. Everybody knows what glue is and what it does. Another girl was looking at the structure of the bone. There are different cells in the bone that were in charge of strengthening the bone and some in charge of destroying the bone. She was looking at how people's activities were affecting these cells in order to damage or strengthen their bones. That was a little bit more difficult to explain. … Glue is something you can relate to but when it is the cells in the bones that are working in some mysterious way, then it gets difficult."*

These emphasize the difficulty in explaining research but the subjects also gave examples on how they manage to overcome that when asked about how people reacted to their profession and their projects. Below, S1 states that she talks about the "end goal" of her project rather than what she does in her practice. She also mentions that the reactions she gets about her profession and projects depend on the profession of the people she gets in contact with. Another remark in her quote is that when she dives into the details, she is aware that there is a lot to learn and that the *learning curve is steep* so at a point in the conversation, she might lose people's interest, implying that there might be a limit to how much detail people are willing to hear. S2's account, on the other hand, talks about the excitement stemming from the fact that she is developing nanodevices/nanorobots.

S1:* "It (people's reaction) actually depends on who I am talking to. … Because when I talk about the end goal, that is to be able to turn off the gene translation, so when I talk about that, people get more interested. …. Because that is something they can relate to, it seems they(people) are interested if they can relate to some part of what I am doing. My sister is studying sociology and for her I could be studying anything in the field of science. It is the same for her. She could not differ between chemistry, biology or nanoscience. I think it is because she does not understand. And quite fast, people tend not to listen. So if the learning curve is really steep they tend to not listen."*
S2:* "Mostly, they would say 'Cool!'. Because I told that it was a nanodevice, a nanorobot - essentially what nanotechnology is about. And most people know about that, that we're producing nanorobots, like, going into the veins and searching for the viruses or bacteria stuff."*

Another question that were directed at the subjects was related to communicating nanotechnology in general. I asked them whether they thought nanotechnology has a communication problem or whether they thought that people have difficulty understanding it. S2 pointed out the need for providing background information to public in order for them to understand it. S1, on the other hand, stated that people do not relate nanotechnology to anything they know because as a field, it is new and people do not have a recollection of it from their former education. In addition, S2 brings in the same strategy that S1 previously talked about: relating nanotechnology to real life by bringing out what it could be used for, in order to make it more understood.

***S2**: "I think if you explain it from the beginning, a small presentation of 30 minutes or 45. I think people would understand. You need the background information to understand what it is actually about. It is difficult to explain otherwise. … I do not think there is a difference(for nanotechnology comparing to other fields). And not because it is new. It would also be difficult for a mathematician to explain a theory as well. Unless he can tell how it is going to be used in the real life. So as long as you relate it to the real life, it would be easier for people to understand.*
***S1**: "It (nanotechnology) is broader in some ways. … Actually in all scientific fields, you can apply nanoscience and that makes it broader. So people do not know what they (scientists) are working with other than they (scientists) are working with really small things. So in that way people do not relate it to anything they know beforehand. Chemistry and physics, people know them because they had it in elementary school so at least they can say some things but nanoscience is nothing they have heard of until university or until they know someone who studies it. It is very new."*

7.2 Online Behaviour

The subjects were asked questions in regards to their online activities. They were asked where they get the news in their field, what their impressions are about scientific social media accounts such as IFLS(a particular science social media account, previously mentioned in chapter 2), and whether their science sharing habits are a reflection of their regular social media habits.

S2 mentioned two accounts on Facebook that share science-related content. Both are social media accounts of scientific journals, Nature and Science. Here one can observe that S2 thinks these accounts provide news that people can understand because they are written by journalists, not by scientists.

S2: *"I specifically search for it. But I am also signed up for Science and Nature on Facebook. They are quite good. … You can go in and read the original article too if you are interested in that. I try to read them. And they are written by the journalists that talked to the scientists. They write it in a way that people would understand. And if you want scientific evidence, you can just go and read the article."*

The issue of credibility also comes to the surface, when asked about IFLS. It can be seen that science blogs or scientific social media accounts are compared to the accounts of credible journals which have a certain process of editing and they have direct contact with the author of the scientific papers. These two aspects seem as quality indicators which most of the blogs and scientific pages do not have. The quality of unedited content also appeared in the previous chapter when a respondent declared her concerns over the quality of the social media accounts as the reason for not following her peers on social media.

S1, in this regard, pointed out that she perceives these accounts as a form of entertainment that are likely to turn into an informing page with interesting content and are likely to get people outside of science interested in science. S2, jokingly, stated that she and a friend of hers were hesitant in sharing some scientific news online because *their network did not need to think that they were more nerdy than they already think they are.* Instead, they share them privately.

S2: *"I think they (IFLS and similar pages) are alright. … Their summaries are most of the times, right. But despite that, I would believe more to Nature and Science. The pieces are going through the editor. And probably the authors of the original paper go through it too. I do not think there is any editing on that (IFLS). I do not think scientists who wrote the paper even saw it before it was published. "*
S1: *"I think they (IFLS and similar pages) are great. For me, they are a form of entertainment. It is like reading the newspaper, sometimes something catches your eye and you get interested in the story. Maybe it is not so relevant to the science I am conducting, but it is like*

trivia. I think it is really entertaining, I like it. I think for people who do not study any scientific field maybe it is maybe easier for them to read that kind of content to get interested in it."

The subjects were also asked about whether they heard of scientific social networks Mendeley, ResearchGate and Academia.edu. Both subjects stated that they heard of ResearchGate, but they did not have a clear picture of what it entailed. This suggests that there could be more done in order promote such pages or investigate their reach on the scientific community

Both subjects mentioned, with different examples, that it is hard to follow other fields through scientific papers because of the language and the fact that science is very specialized. Here one can argue that simplified accounts of science also interests scientists in other fields. Similarly, they touched upon the language barrier between the public and the scientists as well. S1 gave the example of the word *chemical*. It scares people but S1 states that for her, especially as a graduate in chemistry, everything is chemical. Scientists and the public do not speak the same language, which is, of course, not new information, but this highlights both the importance of communication training for scientists if the role of the communicator of science is getting into the job description of scientists.

8 Discussion

In this study, I looked at the concepts of public communication and the change that arrived with the rise of online channels on scientific communication. Then, I focused on nanotechnology as an emerging field and decided to take iNano Center as a sample in order to answer the following questions:

> *To what extent do nanoscientists at iNano use online tools?*
> *To what extent does this usage relate to their scientific work?*
> *What are the similarities and differences between Danish and American nanoscientists in terms of their communication activities?*
> *Are scientists bypassing media professionals in communicating their science?*

Survey results did not indicate a high online presence in terms of communicating science. The nanoscientists who answered the survey *sometimes* share academic content and aim at sharing knowledge and communicating research projects when they do. They mostly use online tools during events, after publishing a paper and when there is an interesting finding in their field. The use of online tools peaked for getting scientific news in comparison to promoting publications or communicating their science, however, the numbers even in the peak were low which supported the lack of online presence.

The sample mostly did not have a formal communication training. The ones who received communication training stated that aim of the training was to reach mostly students and the general public, but the sample mostly aims at reaching their own community in their online activities.

They reported less contact with the media and the public in comparison to the American sample and they reported less agreement with the statement that the contact with the media and the public had a positive impact on them professionally. In predicting the sample's intention to engage in direct or mediated communication, following items overlapped with the American sample:

- Engagement with the media is related to their previous contact, use of online tools to communicate about science, presumed media influence and media motivations.
- Engagement with the public is spurred by the thought that it is important for the society.

The data showed that the sample has more contact with the public than the media. This is encouraging in concluding that the sample is bypassing media professionals in reaching the public.

The accounts of the subjects in the interviews touched upon a few points that should be seen under the light of the survey results. First, there is a need to use *connections* in order to explain science to the public. These connections can be achieved by relating the subject of the study with the concepts people already know of or by providing visuals, the subjects stated. One can argue that this emphasizes the difficulty for scientists to explain their science, which could lead to hesitation in engaging with the public outside of the mediated, planned encounters that the institutions organize. Here it is noteworthy that institutions should include visual training as a part of communication training. Second, in order to achieve a basic understanding, it is helpful to focus on the end goals. It could yield interesting results to investigate the rhetorics that are used in scientists' communication activities. The need for simplifying content could be yet another reason to why scientists do not use online tools. In self-efficacy questions (see **Appendix A**), the scientists reported *neither easy nor difficult*, however, these are self-reported measures which could benefit from further exploration.

As one of the interview subjects pointed out, some of the online tools that were investigated here are the platforms where scientists' private network is also present, thus, they may be more reluctant to use these tools for communicating science. Scientific social networks could be a more suitable way for those who do not want their network to find out how nerdy they are. However, these networks only serve peer communication and would not get the science to the public.

The lack of time is yet another obstacle in using online channels for scientists, but if their peers in the US are already making the effort and getting positive results, where does that lead our sample?

The transition to online channels for scientific communication has already started, but it has not matured. As of now, it is a playground to see which strategies work best and in determining the rules, participation is necessary especially scientists working with nanotechnology. The uncertainties and the hype that that surround nanotechnology can benefit from new frames that nanoscientists come up with using the online tools.

This study carries limitations, the low response rate being the main one. This study does not and claim to have reached general conclusions about the practice of nanotechnology in Denmark or at iNano Center. However, the survey and the interviews gave interesting results and represented interesting nuances. For these nuances to get a stronger position, different strategies for getting higher response rate should be visited and the number of interviews should be increased, and this study should, then, seek to reach more general conclusions. In addition, there could be bias in the sample because scientists that already engage in communication activities could be more inclined to answer a survey with this scope.

References

Amenta, V., Aschberger, K., Arena, M., Bouwmeester, H., Moniz, F. B., Brandhoff, P., … Peters, R. J. (2015). Regulatory aspects of nanotechnology in the agri-feed-food sector in EU and non-EU countries. *Regulatory Toxicology and Pharmacology*. http://doi.org/10.1016/j.yrtph.2015.06.016

Armitage, C. J., & Conner, M. (2001). Efficacy of the Theory of Planned Behaviour: a meta-analytic review. *The British Journal of Social Psychology / the British Psychological Society*, *40*(Pt 4), 471–499. http://doi.org/10.1348/014466601164939 Association of Scientific Workers. (1947). *Science and The Nation*. Hardmonsworth: Penguin Books.

Beck, U. (1992). Risk society: Towards a new modernity. *Nation*, *2*(2), 260. http://doi.org/10.2307/2579937

Bik, H. M., & Goldstein, M. C. (2013). An Introduction to Social Media for Scientists. *PLoS Biology*, *11*(4), e1001535. http://doi.org/10.1371/journal.pbio.1001535

Brossard, D. (2013). New media landscapes and the science information consumer. *Proceedings of the National Academy of Sciences*, *110*(Supplement_3), 14096–14101. http://doi.org/10.1073/pnas.1212744110

Brossard, D., & Lewenstein, B. V. (2010). A critical Appraisal of Models of Public Understanding of Science. In L. Kahlor & P. A. Stout (Eds.), *Communicating Science: New Agendas in Communication* (1st ed., pp. 11–39). Oxon, New York: Routledge.

Burri, R. V., & Dumit, J. (2008). Social Studies Of Scientific Imaging And Visualization. In E. J. Hackett, O. Amsterdamska, M. Lynch, & J. Wajcman (Eds.), *The Handbook Of Science And Technology Studies* (3rd ed., pp. 297–317). Cambridge: The MIT Press.

Cacciatore, M. A. (2014). Public engagement: The benefits of communicating. *Nature Nanotechnology*, *9*(10), 749–749. http://doi.org/10.1038/nnano.2014.221

Cacciatore, M. A., Scheufele, D. A., & Corley, E. A. (2014). Another (methodological) look at knowledge gaps and the Internet's potential for closing them. *Public Understanding of Science*, *23*(4), 376–94. http://doi.org/10.1177/0963662512447606

Chrystal, P., & Laundon, S. (2015). *Secret Middlesbrough* (1st ed.). Amberley Publishing. Commission of The European Communities. (2005). *Nanosciences and nanotechnologies: An action plan for Europe 2005-2009*. Brussels. Retrieved from ftp://ftp.cordis.europa.eu/pub/nanotechnology/docs/nano_action_plan2005_en.pdf

Cook, C., Heath, F., & Thompson, R. L. (2000). A meta-analysis of response rates in web- or internet-based surveys. *Educational and Psychological Measurement*, *60*(6), 821–836. http://doi.org/10.1177/00131640021970934

Corley, E. & Scheufele, D. (2010). Outreach going wrong? When we talk nano to the public, we are leaving behind key audiences. *The Scientist*, *24*, 22. http://doi.org/10.1086/266828

Couper, M. P. (2008). *Designing Effective Web Surveys* (1st ed.). New York: Cambridge University Press.

de Ridder-Vignone, K. D. (2012). Public Engagement And The Art Of Nanotechnology. *Leonardo*, *45*(5), 433–438.

de Ridder-Vignone, K. D., & Lynch, M. (2012). Images and Imaginations: An Exploration of Nanotechnology Image Galleries. *Leonardo*, *45*(5), 447–454.

Deutskens, E., De Ruyter, K., Wetzels, M., & Oosterveld, P. (2004). Response rate and response quality of Internet-based surveys: An experimental study. *Marketing Letters*, *15*(1), 21–36. http://doi.org/10.1023/B:MARK.0000021968.86465.00

Dudo, A., Kahlor, L., AbiGhannam, N., Lazard, A., & Liang, M.-C. (2014). An analysis of nanoscientists as public communicators. *Nature Nanotechnology*, *9*(10), 841–844. http://doi.org/10.1038/nnano.2014.194

Dunwoody, S. (2014). Science Journalism: prospects in the digital age. In M. Bucchi & B. Trench (Eds.), *Routledge Handbook of Public Communication of Science and Technology* (2nd ed., pp. 27–39). Oxon, New York: Routledge.

Dunwoody, S., & Ryan, M. (1985). Scientific Barriers to the Popularization of Science in the Mass Media. *Journal of Communication*, *Winter*, 26–42.

Einsiedel, E. F. (2000). Understanding “publics” in public understanding of science. In M. Dierkes & C. von Grote (Eds.), *Between understanding and trust—The public, science and technology* (pp. 205–215). London, New York: Routledge.

Eysenbach, G. (2011). Can tweets predict citations? Metrics of social impact based on Twitter and correlation with traditional metrics of scientific impact. *Journal of Medical Internet Research*, *13*, e123. http://doi.org/10.2196/jmir.2041

Fiske, S. T., & Taylor, S. E. (1991). *Social Cognition* (2nd ed.). New York: McGraw-Hill.

Fox, J. (2012). Can blogging change how ecologists share ideas? In economics, it already has. *Ideas in Ecology and Evolution*, *5*, 74–77. http://doi.org/10.4033/iee.2012.5b.15.f

Friedman, S. M., & Egolf, B. P. (2005). Nanotechnology: risks and the media. *IEEE Technology and Society Magazine*, *24*(4), 5–11. http://doi.org/10.1109/MTAS.2005.1563496

Gartner Inc. (2015). Gartner's 2015 Hype Cycle for Emerging Technologies Identifies the Computing Innovations That Organizations Should Monitor. Retrieved November 23, 2015, from http://www.gartner.com/newsroom/id/3114217

Gaskell, G. (2005). Imagining nanotechnology: cultural support for technological innovation in Europe and the United States. *Public Understanding of Science*, *14*, 81–90. http://doi.org/10.1177/0963662505048949

Giles, J. (2004). Nanotech takes small step towards burying "grey goo". *Nature*, *429*(6992), 591. http://doi.org/10.1038/429591b

Hartz, J., & Chappell, R. (1997). *Worlds Apart: How the Distance Between Science and Journalism Threatens America's Future*. Michigan: First Amendment Center.

Hessenbruch, A. (2004). Nanotechnology and the Negotiation of Novelty. In J. Baird, Davis; Nordmann, Alfred; Schummer (Ed.), *Discovering the Nanoscale* (Second pri, pp. 135–144). Amsterdam: IOS Press.

Holbrook, A. L., Krosnick, J. a., & Pfent, A. (2007). The Causes and Consequences of Response Rates in Surveys by the News Media and Government Contractor Survey Research Firms. *Advances in Telephone Survey Methodology*, *60607*, 499–678. http://doi.org/10.1002/9780470173404.ch23

Hurd, J. M. (2004). Scientific Communication: new roles and new players. *Science & Technology Libraries*, *25*, 5–22. http://doi.org/10.1300/J122v25n01_02

Irwin, A. (1995). *Citizen Science: A Study of People, Expertise and Sustainable Development* (1st ed.). London: Routledge.

iNano Center. (2015). *iNano Review 2014/2015*. Aarhus. Retrieved from http://www.e-pages.dk/aarhusuniversitet/1203/

Kjaergaard, R. S. (2010). Making a small country count: nanotechnology in Danish newspapers from 1996 to 2006. *Public Understanding of Science*, *19*(1), 80–97. http://doi.org/10.1177/0963662508093090

Kunreuther, H. . (2001). Protective decisions: Fear or prudence. In S. J. Hoch, H. C. Kunreuther, & R. E. Gunther (Eds.), *Wharton on Making Decisions* (John Wiley, pp. 259–272). New York: John Wiley and Sons.

Landau, J., Groscurth, C. R., Wright, L., & Condit, C. M. (2008). Visualizing nanotechnology: the impact of visual images on lay American audience associations with nanotechnology. *Public Understanding of Science*, *18*(3), 325–337. http://doi.org/10.1177/0963662507080551

Laslo, E., Baram-Tsabari, a., & Lewenstein, B. V. (2011). A growth medium for the message: Online science journalism affordances for exploring public discourse of science and ethics. *Journalism*, *12*, 847–870. http://doi.org/10.1177/1464884911412709

Letierce, J., Passant, A., Decker, S., & Breslin, J. G. (2009). Understanding how Twitter is used to spread scientific messages. *October*, 8. Retrieved from http://journal.webscience.org/314/

Lewenstein, B. V., Gorss, J., & Radin, J. (2005). The salience of small: Nanotechnology coverage in the American press, 1986-2004. In *ICA -The Annual Meeting of The International Communication Association*.

Luhmann, N. (2000). *Reality of Mass Media*. Stanford University Press.

Lynch, M., & Edgerton, S. Y. J. (1988). Aesthetics and Digital Image Processing: Representational Craft in Contemporary Astronomy. In G. Fyfe & J. Law (Eds.), *Picturing Power: Visual Depictions And Social Relations* (1st ed., pp. 184–220). London: Routledge.

Maille, M.-E., Saint-Charles, J., & Lucotte, M. (2010). The gap between scientists and journalists: the case of mercury science in Quebec's press. *Public Understanding of Science*, *19*(1), 70–79. http://doi.org/10.1177/0963662509102690

Mccall, R. B. (1987). Science and the Press Like Oil and Water ? *American Psychologist*, 87–94.

Medin, D. L., & Bang, M. (2014). The cultural side of science communication. *Proceedings of the National Academy of Sciences*, *111*(Supplement_4), 13621–13626. http://doi.org/10.1073/pnas.1317510111

Meho, L. I. (2006). The Rise and Rise of Citation Analysis. *Physics World*, *20*(114), 15. Retrieved from http://arxiv.org/abs/physics/0701012

Miller, D. (1999). Mediating Science: Promotional Strategies, Media Coverage, Public Belief and Decision Making. In E. Scanlon, E. Whitelegg, & S. Yates (Eds.), *Communicating Science: Contexts and Channels* (1st ed., pp. 206–26). London: Routledge.
National Science Board. (2010). *Science and Engineering*. *Science and Engineering Indicators 2010*. Arlington, VA.

National Science Board. (2012). *Science and technology: Public attitudes and understanding. Science and Engineering Indicators 2012*. Arlington, VA.

National Science Board. (2014). *Science & Engineering Indicators*. *Science and Engineering Indicators 2014*. Arlington VA. Retrieved from http://www.nsf.gov/statistics/seind14/index.cfm/etc/pdf.htm

Nelkin, D. (1989). Journalism and science: The creative tension. In M. Moore (Ed.), *Health Risks and the Press: Perspectives on Media Coverage of Risk Assessment and Health* (pp. 53–71). Washington DC: Media Institute.

Nielsen, K. H. (2008). Nanotech, Blur and Tragedy in Recent Artworks by Gerhard Richter. *Leonardo*. http://doi.org/10.1162/leon.2008.41.5.484

Office of Science and Technology and Wellcome Trust. (2000). *Science and the Public: A Review of Science Communication and Public Attitudes to Science in Britain*. Retrieved from http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_peda/documents/web_document/wtd003419.pdf

Ouellette, J. a., & Wood, W. (1998). Habit and intention in everyday life: The multiple processes by which past behavior predicts future behavior. *Psychological Bulletin*, *124*(1), 54–74. http://doi.org/10.1037/0033-2909.124.1.54

Peters, H. P. (2013). Gap between science and media revisited: Scientists as public communicators. *Proceedings of the National Academy of Sciences*, *110*(Supplement_3), 14102–14109. http://doi.org/10.1073/pnas.1212745110

Popkin, S. L. (1994). *The Reasoning Voter: Communication and Persuasion in Presidential Campaigns* (2nd ed.). Chicago: IL: University of Chicago Press.

Priem, J., Taraborelli, D., Groth, P., & Neylon, C. (2010). Altmetrics: A manifesto. Retrieved November 21, 2015, from http://altmetrics.org/manifesto/

Regenberg, A. C. (2010). Tweeting Science and Ethics: Social Media as a Tool for Constructive Public Engagement. *The American Journal of Bioethics*, *10*(5), 30–31. http://doi.org/10.1080/15265161003743497

Research International. (2000). Science and the Public: Mapping Science Communication Activities. Retrieved from http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_peda/documents/web_document/wtd003418.pdf

Ruivenkamp, M., & Rip, A. (2014). Nanoimages As Hybrid Monsters. In C. Coopmans, J. Vertesi, M. E. Lynch, & S. Woolgar (Eds.), *Representation In Scientific Practice Revisited* (1st ed., pp. 177–200). ambridge and London: The MIT Press.

Russell, N. (2010). *Communicating Science: Professional, Popular, Literary* (1st ed.). Cambridge University Press.

Scheufele, D. a., & Lewenstein, B. V. (2005). The Public and Nanotechnology: How Citizens Make Sense of Emerging Technologies. *Journal of Nanoparticle Research*, *7*(6), 659–667. http://doi.org/10.1007/s11051-005-7526-2

Schneider, S. H. (1986). Both sides of the fence: The scientist as source and author. In S. M. Friedman, S. Dunwoody, & C. L. Rogers (Eds.), *Scientists and Journalists: Reporting Science as News* (pp. 215–222). New York: Free Press.

Secko, D. M., Tlalka, S., Dunlop, M., Kingdon, A., & Amend, E. (2011). The unfinished science story: Journalist-audience interactions from the Globe and Mail's online health and science sections. *Journalism*, *12*(7), 814–831. http://doi.org/10.1177/1464884911412704

Shuai, X., Pepe, A., & Bollen, J. (2012). How the Scientific Community Reacts to Newly Submitted Preprints: Article Downloads, Twitter Mentions, and Citations. *PLoS ONE*, *7*(11), e47523. http://doi.org/10.1371/journal.pone.0047523

Simon, H. a. (1979). Rational decision making in business organizations. *The American Economic Review*, *64*(4), 493–514. http://doi.org/10.2307/1808698

The Royal Society of London. (1985). *The public understanding of science.*

Thomas, S. J. (2004). *Using Web and Paper Questionnaires for Data-based Decision Making: From Design to Interpretation of the Results*. California: Corwin Press.

Tichenor, P. J., Donohue, G. A., & Olien, C. N. (1970). Mass Media Flow and Differential Growth in Knowledge. *Public Opinion Quarterly*, *34*(2), 159–170. http://doi.org/10.1086/267786

Trench, B. (2008a). Internet: Turning science communication inside-out? In B. Trench & M. Bucchi (Eds.), *Handbook of public communication of science and technology* (1st ed., pp. 185–198). Oxon, New York: Routledge.

Trench, B. (2008b). Towards an Analytical Framework of Science Communication Models. In D. Cheng, T. Gascoigne, B. Schiele, M. Claessens, J. Metcalfe, & S. Shi (Eds.), *Communicating Science in Social Contexts: New models and Practices* (pp. 119–135). Springer Science + Business Media B.V.

Van Noorden, R. (2014). Online collaboration: Scientists and the social network. *Nature*, *512*(7513), 126–129. http://doi.org/10.1038/512126a

Visser, P. S., Krosnick, J. A., Marquette, J., Curtin, M., & Krosnick, J. O. N. A. (1996). American Association for Public Opinion Research Mail Surveys for Election Forecasting ? An Evaluation of the Columbus Dispatch Poll *60*(2), 181–227.

Waldron, A. M., Spencer, D., & Batt, C. a. (2006). The current state of public understanding of nanotechnology. *Journal of Nanoparticle Research*, *8*(5), 569–575. http://doi.org/10.1007/s11051-006-9112-7

Appendices

Appendix A - Questions and variables

Concept & Measure	Question	M	SD
Previous Behavior: Direct (1-6 scale) (5 or more = high)	In the last 5 years, approximately how often have you been in contact with non-scientists to talk about or write about your research (e.g., lay public, school children, politicians, etc.)?	3.19	2.08
Previous Behavior: Media (1-6 scale) (5 or more = high)	In the last 5 years, approximately how often have you had contact with media or communication professionals (journalists, public relations practitioners, etc.)?	2.36	1.92
Media Contact Intentions (1-5 scale) (strongly agree=high)	I plan to have contact with media professionals in the future regarding my research.	3.61	0.81
	I would like to have more contact with the media.	3.34	0.91
	Pearson's *r* Averaged index	**0.37** 3.48	 0.86
Direct Contact Intentions (1-5 scale) (strongly agree=high)	I plan to engage in communication efforts regarding my research in the future.	3.95	0.79
	I would like to have more contact with public audiences.	3.79	1.05
	Pearson's *r* Averaged index	**0.55** 3.87	 0.92
Impact 5 scale (strongly agree =high)	My contact with the media has had a positive impact on me professionally.	3.30	0.80
5 scale (strongly agree =high)	My public communication efforts have had a positive impact on me professionally.	3.51	0.74
Use of Online-Only Media for Science News	How often do you use the following media to get news about science? • Blogs • Online forums, message boards, threads,	 2.02 2.57	 1.00 1.27

(1-5 scale) (every day = high)	wikis ● Social networks (Facebook, LinkedIn, etc.) ● Micro-blogging sites (Twitter, Tumblr, etc.) ● Video sharing sites (YouTube, Vimeo etc)	 2.64 1.50 2.74	 1.21 0.80 1.04
	Reliability score(α) Averaged index	**0.64** 2.3	 1.06
Use of Traditional Media for Science News (1-5 scale) (every day = high)	How often do you use the following media to get news about science? ● Television ● Magazines ● Newspaper ● Radio	 2.07 3.05 2.69 1.93	 0.87 1.10 0.92 0.92
	Reliability score(α) Averaged index	**0.62** 2.44	 0.95
Use of Online Tools to Communicate about Science (1-5 scale) (every day = high)	How often do you use the following media to communicate about science? ● Blogs ● Online forums/message boards/threads/wikis ● Social networks (e.g., Facebook, LinkedIn) ● Micro-blogging sites (e.g., Twitter) ● Video sharing sites (e.g., Youtube)	 1.40 2.10 2.07 1.43 1.67	 0.66 1.30 1.11 0.74 0.98
	Reliability score(α) Averaged index	**0.70** 1.73	 0.96
Use of Traditional Media to Communicate about Science (1-5 scale) (every day = high)	How often do you use the following media to communicate about science? ● Television ● Magazines ● Newspaper ● Radio	 1.32 1.71 1.49 1.37	 0.57 0.96 0.84 0.62
	Reliability score(α) Averaged index	**0.80** 1.47	 0.75
Attitude: Personal Enjoyment (1-5 scale)	I enjoy … ● Explaining my research and its results to the public. ● Describing the possible practical uses of my research. ● Evaluating political decisions based on my professional expertise. ● Giving practical advice based on my professional expertise.	 3.78 3.95 3.30 3.93	 0.95 0.68 1.09 0.69

	• Discussing the social and ethical aspects of my research. • Contributing to public debate about policy related to science.	3.58 3.53	0.87 0.78
	Reliability score(α) Averaged index	**0.81** 3.68	 0.84
Communication Self-Efficacy (1-5 scale) (very easy=high)	The skills needed for public communication are often different from the skills you use to do research and communicate it to your peers. Looking at your own skill set, would you find it difficult or easy to … • Explain scientific facts in a way lay people can understand. • Debate rather than just lecture. • Adjust to different kinds of lay audiences. • Anticipate lay people's potential points of interest in your work. • Awaken lay people's interest in science.	 3.21 3.13 3.36 3.05 2.92	 1.03 1.08 0.87 0.76 0.96
	Reliability score(α) Averaged index	**0.78** 3.13	 0.94
Communication Training (No/Yes)	Have you ever had formal training in communication skills?	33%	
	If you have received formal training in communication skills, who were those skills intended to help you reach more effectively? • Students. • Scientists. • General public. • Politicians / policy makers. • Funding sources. • Media professionals	 31% 15% 31% 4% 4% 15	
Norms: Negative External (1-5 scale) (very important=high)	How important are the following considerations if/when you correspond with the media or engage in public communication related to your research? • Possible critical reaction from peers. • Possible critical reactions from the head of my department. • Possible critical reactions from the public. • Clashes with the scientific culture.	 3.74 3.49 3.36 3.26	 1.04 1.19 1.18 1.04
	Reliability score(α)	**0.82**	

	Averaged index	3.46	1.11
Norms: Positive External (1-5 scale)	How important are the following considerations if/when you correspond with the media or engage in public Communication related to your research? ● Enhanced personal reputation among peers. ● Enhanced public reputation. ● Influence on public debate.	 3.38 3.21 3.85	 1.16 1.10 0.93
	Reliability score(α) Averaged index	**0.73** 3.48	 1.06
Attitude: Importance for Society (1-5 scale)	Below you will find a list of public communication activities. How important is each activity to the welfare of society? ● Explaining your research and its results to the public. ● Describing the possible practical uses of your research. ● Evaluating political decisions based on your professional expertise. ● Giving practical advice based on your professional expertise. ● Discussing the social and ethical aspects of your research. ● Contributing to public debate about policy related to your research.	3.86 4.22 3.54 3.81 3.59 3.84	0.89 0.85 1.04 0.94 1.17 1.09
	Reliability score(α) Averaged index	**0.89** 3.81	 1.0
Presumed Media Influence (1-5 scale)	Please indicate your level of agreement or disagreement with the following statements: ● Universities find it more difficult to deny tenure to candidates who make frequent media appearances. ● Published research that also appears in the mass media gets more attention from other researchers. ● Published research that also appears in the mass media tends to be more frequently cited. ● Media appearances help scholars attract excellent students. ● Media appearances help scholars get funding. ● Media appearances help scholars receive	3.03 3.68 3.38 3.84 3.92 3.19	0.73 0.88 0.86 0.87 0.68 0.84

	the esteem of their colleagues.		
	Reliability score(α) Averaged index	**0.75** 3.51	 0.81
Media Motivations (1-5 scale)	Please indicate your level of agreement or disagreement with the following statements: ● When journalists have approached me for an interview about my area expertise in the past (or if they do so in the future), I have generally tried to cooperate. ● I try to be as helpful as I can to the media relations efforts of my primary employer.	3.97 4.00	0.73 0.67
	Pearson's *r* Averaged index	**0.63** 3.99	 0.70
Frequency of sharing/posting content online 5 Scale (Always=high)	How often do you share/post academic material online?	2.46	1.17
	How often do you share/post non-academic material online?	2.65	1.38
	How often do you share content from others online?	2.41	1.17
Motivations for publishing and sharing content	What is your drive in posting and sharing material online? ● To share knowledge / study / work about your field of expertise ● To communicate about some of your research projects ● To increase your network ● To communicate about venues (conference, workshops, tutorial, talk, etc.) ● Because it is compulsory ● Other	34.3% 25.4% 16.4% 12.7% 3.8% 7.5%	
Target Group	Who do you aim to reach when you publish and share material online? ● General audience ● Technical audience ● Your own community - peers ● Students ● Business audience ● Other ● Do not know	26.9% 15.9% 32.3% 15.9% 2.5% 2.5% 4%	

Time Frame of publishing content	When do you publish academic content the most? ● During events (conferences, workshops etc. ● After publishing a paper ● After my coworkers or scientists in my university published a paper ● When there is an interesting finding/innovation in my field ● When prominent scientists share a content ● When I think there is a need for clarification/correction	 20% 27% 13% 25.7% 9.6% 4.8%	
Promotion 5 Scale (Always=high)	How often do you use the following media to promote your publications? ● Blogs ● Online forums/message boards/threads/wikis ● Social networks (e.g., Facebook, LinkedIn) ● Micro-blogging sites (e.g., Twitter) ● Video sharing sites (e.g., Youtube)	 1.30 1.76 2.19 1.27 1.32	 0.62 1.14 1.33 0.61 0.63
	Reliability score(α) Averaged index	**0.69** 1.57	 1.08
Communication between peers 5 Scale (Extremely beneficial=high)	Do you follow/friend/connect/like your peers on social media?	76%	
	How beneficial would you consider connecting to peers on social media?	3.00	0.78
	What is your reason for not connecting with your peers on social media?		

Appendix B - Scales

Number of contacts	Agreement	Frequency
No contact	Strongly disagree	Never
Once	Disagree	Almost never
Twice	Neither agree nor disagree	Sometimes
Three times	Agree	Almost every day
Four times	Strongly agree	Every day
Five or more times		

Importance	Difficulty	Frequency
Not at all important	Very difficult	Never
Low importance	Difficult	Rarely
Neutral	Neutral	Sometimes
Moderately important	Easy	Usually
Very important	Very easy	Always

Importance
Not at all beneficial
Slightly beneficial
Somewhat beneficial
Very beneficial
Extremely beneficial

Appendix C - Interview Questions

❐ Could you tell me a bit about yourself? What have you studied? What are you working on at the moment?

❐ Is it difficult to explain to people outside of university ?

❐ What are their reactions when you tell them what you do?

❐ Do you think that nanotechnology has a communication problem? Why? Why not?

❐ What do you think about the science-public relationship?

❐ In the analysis of my survey, I can see that people use social media to get news about science more than communicating science and their research. Why do you think that is the case? Does that apply to you as well?

❐ Where do you get your science news in your field or in general about science?

❐ What is your impression of IFLS and pages alike?

❐ Have you heard of online scientific networks such as Mendeley, Research Gate and Acedemia.edu?

Appendix D - Descriptions of the Interview Subjects

S1

The subject has a bachelor and a masters degree in chemistry.
He has recently started his PhD in nanotechnology.
He is working on synthesizing nucleic bases for synthetic biology applications.

S2

The subject has a bachelor and a masters degree in nanotechnology.
In his masters he specialized in biochemistry.
He had his PhD in nanoscience on DNA nanotechnology.
He recently handed in his dissertation and now he is a postdoc working with biochemistry.

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ISSN 1903-413X

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