

Strategies for the public communication of nanotechnologies: a three country comparative study

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Abstract

Modern society is characterized by a strong feedback relation with science and technology (S&T): social context influences the path for emerging technologies and these in turn shape the way people produce, work and live. When a new and powerful technology wave arises, with the potential to transform different social and economic sectors, development opportunities appear but they are restricted for those agents informed and active enough to take advantage from them.

Over the last 15 years, nanotechnologies (NT) have established themselves as a powerful cluster of emerging technologies with the promise becoming the next big technological revolution. Research on this area, that involves the manipulation of matter at the atomic and molecular scale, has received support for over 50 billion dollars in public support worldwide; even when most people don't have an idea of what NT are.

Public communication of science and technology plays a key role in the social construction of NT, offering a perspective on the subject for non-experts and, with it, influencing how agents comprise these developments and interact with them. This paper is dedicated to identifying how different strategies for the popularization of NT get society involved with these emerging technologies in Spain, United States and Mexico; with this we intend to establish whether they serve as facilitators of a rich social participation or as mere propaganda tools for the adoption of new technologies.

Introduction

Science and technology (S&T) hold an interactive relation with social, cultural and economic factors. As Lewenstein (2005) points out, S&T only exist in a social context and we cannot understand their advance without grasping both the social conditions that produce them and –at the same time- the scientific and technological conditions that shape society. There is not the technical on one side and the social on the other, as two worlds or two heterogeneous processes, society and technical change mold each other (Salomon, 1988).

So, when a powerful emerging technology –such as NT- appears, it arises questions on how it works but –more importantly- how it is going to transform society. It also presents the problem of how to discuss a series of advances that cannot be seen or felt directly but are already changing our lives.

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NT are a S&T system that has received huge investments globally, over USD \$ 67 billion from the public sector from 2001 to 2011 (Cientifica, 2011), and that carries over to huge expectations and concerns. Specifically, on what concerns science communication, there are different institutions worried about an adverse public reaction; similar to that to genetically modified crops (Macnaghten, 2010). This has resulted, in some cases, into a phobia to nano-phobia (Rip, 2006) that leads to strategies oriented to the creation of a favorable public perception of NT.

That is way authorities, under the flag of responsible innovation, look to characterize social concerns in a proactive manner for an early incorporation in NT research programs (Macnaghten, 2010); but we can also understand this action as efforts to monitor public reactions and design a society that will live with nano products, looking to pave the way to incorporate this novel technologies in society (Bensaude-Vincent, 2012). We find here a possible clash of visions from which different organizations approach the public communication and social construction of NT: with technologic offer led transformation –with the “market” shaping new products and the government acting as a change facilitator- on one hand, and a social pull defined route –that answers to the needs and aspirations of different social actors- on the other.

In this context, the model of public communication (PC) of S&T and the media frame used in popularization strategies are fundamental to shape the position of citizens and social organizations regarding the advance of NT; specially when relating to social issues associated with them, such as funding priorities, health and environmental risks, ethical implications, or labor impact. On this paper we discuss the main characteristics that distinguish the PC of nanotechnologies when compared to other S&T subjects, and then we will present the results of the analysis of 50 PC of NT strategies in Mexico, Spain and the United States.

Challenges and tools for the PC of Nanotechnologies

The popularization of NT cannot be approached the same way as the communication of any other S&T subject with the lay public; nanotechnologies are conceptually richer and more complex because their discussion requires a lot unknown concepts for the public, but necessary for their understanding (Sanchez-Mora & Tagueña, 2011). From our perspective there are five main obstacles that have to be taken into consideration for the PC of this subject:

i) Invisibility. The phenomena that make nanotechnologies possible are so small that they are invisible to the naked eye, but still they are the foundation of amazing advances. A big challenge is to help people imagine something that they cannot see directly and requires advanced microscopy techniques to be visualized (Priest, 2012).

ii) Size and scale. For most people a nanometer is something too abstract, it is hard for them to get a clear idea of the scale of work in NT. Batt (2011) points out that researchers on this area have a certain level of understanding of size through the learnt ability of translating measures and events from the nano scale, but the lay public does not have this advantage; the comprehension of sizes this small calls for creative approaches.

iii) Multidiscipline. S&T in school are usually reviewed from the perspective of specific disciplines, which gets us used to see thing from the isolated eyes of physics, chemistry or biology. NT involve concepts, methodologies and semantic fields coming from a broad range of disciplines, meaning their discussion needs a wider scientific perspective.

iv) Quantum principles. The rules of nature at the nano scale, and below, allow for our Universe to exist as we know it but often quantum physics principles are counter-intuitive and even strange for the lay public.

v) Myths. Ever since the concept of nanotechnology was first introduced into public discussion this system has been associated to both utopic and apocalyptic scenarios: from molecular assemblers able to build anything to self-replicating nanobots that could be the end of civilization. A good PC of the subject must present a realist perspective that does not lean into any extreme.

We see it is not easy to communicate NT but there are also advantages we can rely upon. Serena (2013) highlights the abundance of nano products in the market and the curiosity created by nano related science fiction; also we can use historic, biographic and anecdotic elements related to NT to create emotional and cognitive bonds with the public. Finally as an element for more clarity, Batt (2011) proposes to use the more general and basic approach for the popularization of NT, by contemplating 4 essential concepts:

1. All things are made of atoms.
2. Molecules have shape and size.
3. At nanometer scale, atoms are in constant motion.
4. Molecules in their nano scale environment show unexpected properties.

These four technical pillars ease the comprehension of the phenomena that make NT possible and allow for richer and deeper discussions: from novel characteristics of nano products available on the market, to the possible benefits coming from new developments, risks associated to these technologies, what society expects from NT and other social issues.

Relevant Studies

Academic work on PC of NT so far has focused on two main points: public knowledge and perception on one side and content and framing studies in mass media (magazines and newspapers for the most part) on the other.

The results of the first type of research show that most people are not familiar with the concept of NT and practically have no knowledge on what they are and what they could become (Macnaghten, 2010). Despite such ignorance there does not seem to be any fear to unknown: a meta-analysis of 22 studies performed between 2002 and 2009 in the United States, Canada, Europe and Japan, found low levels of familiarity but with a perspective of benefits that outweigh risks by a 3 to 1 margin, although 44% of people have not established a posture yet (Roco et al., 2011).

Moderate optimism from the public, that tends to underestimate rather than overestimate risks, is quite strange when considering growing evidence on possible negative effects of NT. Priest (2012) points out we normally ignore or belittle of technologies that offer clear benefits –such as mobile phones and cars- but NT biggest benefits have yet to come and even so the public perspective is still favorable. For most companies and government agencies things are fine that way but indifference to risks presents a bigger challenge for public communication efforts: to bring attention to the existence of risks but without taking an alarmist stand (Ibid). For this, non-governmental organizations have played a big role as agents that push for specific actions for the discussion of risks, work to bring them to broader audiences and get them involved in public policy.

Social participation -with risks as a main subject- is on the table and pushing its way through the PC of NT. But the fact that the matter is discussed does not guarantee social advances,

it depends on the information that is reaching different actors and the attention being paid to their input. The frames for risks discussion depend on the interests of the types of organizations that represent the main sources of information (Berube, et al., 2010): private sector, government, scholars and social organizations.

For instance, Lewenstein (2005) highlights that many researchers in NT concern that media coverage on the subject focuses too much on risks and not enough on benefits, which could influence public opinion and difficult the achievement of the anticipated potential for NT. We find a power struggle right here: researchers want to define what is an proper development for the field, without the fear that some other social group being able to use its power to influence the route of NT (Ibid). In any case, this reinforces Hilgartner's (1990) idea that those doing public communication of S&T manipulate the process to answer to their interests. Considering that most NT popularization strategies are led by nano-experts, we find a trend of privileging the technical side of NT over issues of health and environment risks or ethical concerns (Besley, 2010).

If we consider all information discussed in popularization to be valid from the technical point of view, there are not many variations to be made on the background content, frames are the main element to try to influence the posture of people and organizations on NT. It must be remembered that, by highlighting some aspects instead of others, frames have a powerful impact on the way a certain subject is perceived; influencing certain values or judgments on the public or in how people perceive a problem and its consequences (Lively et al., 2012). Although there are a lot of different possibilities of frames for the PC of NT, it is useful to have a reference of the perspective offered to the public; based on the work of Macnaghten (2010) and Lively et al. (2012), we have built a 5 level typology for the different frames that bring NT to the public:

- i) Utopia.** Promises a NT led revolution that will extend and transform human capabilities, both physical and sensorial, to go beyond natural restrictions.
- ii) Possible advance.** Points at NT as a new kind of S&T that could contribute to expected milestones through existing trajectories in multiple sectors and application spheres.
- iii) Generic risk.** Discusses possible dangers associated to NT, calls for attention on the existence of a cost inherent to the benefits but does not call for regulation.
- iv) Regulation.** Introduces politic processes in an explicit fashion, emphasizes in the need of government action to protect the public.
- v) Conflict.** Puts the emphasis on disputes between the interests of different actors and how power struggles shape the direction for the advance of NT. Specific political terms are discussed.

This typology will serve as the foundation to identify the frame used in PC of NT strategies discussed in this paper and, with it, help characterize the NT perspective offered to society.

Study overview

Our study comprises PC of NT strategies in the United States, Spain and Mexico over the 2000-2013 period. The time table frame was chosen according to the boom in national initiatives for the development of NT, with the investment commitment this represented, and aims to identify the characteristics of the programs that intend to get society involved in this S&T wave. Specifically we picked strategies that worked in three media with distinctive ways of incorporating different sectors of the public in the S&T discussion:

- a) Books. They are usually associated with deficit communication, linear and unidirectional, with a passive role for the public, but they offer a deeper analysis than any other media. With the right approach books can trigger interest and public participation.
- b) Interactive exhibits and recreational workshops. The key for this dynamics is a three level interaction between the communicators (who are really facilitators) and the public: physical, intellectual and emotional. They promote an active role for participants, so their interests and concerns are incorporated in the communication process. This way they can adjust to different conditions, according to the sectors of the public involved.
- c) Videos available on youtube. Videos are a powerful tool for public communication of S&T, by combining speech with images and sound they stimulate the public in a meaningful way that allows a bigger impact. Previously the possibility of watching a video was restricted to television transmission, the possession of the material or its public screening. Now, youtube offers –as never before- the possibility to access this materials anytime from anyplace with internet access. Also, with the power of social networks, this availability offers the opportunity of sharing, recommending and discussing the videos.

Our research questions where: What kind of participation is built through the PC of NT? How does the context of an strategy influence the PC of S&T model used, the information frame and the message? Which organizations promote, support and develop the PC of NT? What kind of message is the PC of NT bringing to the public?

As for the methodology, first we made an inventory of all the strategies to be considered in the study which resulted in a total of 83 strategies (table 1). Afterwards we selected 50 strategies, privileging projects that had national collaborations, the participation of different sectors or offered unique perspectives for the discussion of NT. The result of the selection is presented in table 2.

Tab. 1: Inventory of public communication of nanotechnologies strategies in the United States, Spain and Mexico in the 2000-2013 period

Country	Books	Exhibits / Workshops	Videos	Total
United States	25	18	9	52
Spain	10	4	2	16
Mexico	8	3	6	17
	43	25	17	85

Tab. 2: Relation of strategies included in the study

Country	Books	Exhibits / Workshops	Videos	Total
United States	15	8	7	30
Spain	4	3	2	9
Mexico	5	2	4	11
	24	13	13	50

Once the strategies were selected we proceeded to conduct interviews, direct and electronic, with their leaders to gather data about the conditions around and inside the project. Then we conducted a direct analysis of the products generated by each strategy; in the case of exhibits and workshops we made an effort to visit them directly but, when that was not possible, we

arranged with the leaders to receive brochures, technical information and even videos that helped us understand their characteristics. All the information collected in this process was captured in a matrix, based on four aspects: context, model for the PC of S&T, information frame, and content. With all this information we established a profile for the PC of NT strategies, their distinctive conditions in each country and the correlation between other relevant elements.

Results

On the institutional conditions that led to the creation of strategies, 34 cases originated in educative organizations such as universities, museums and research centers; 14 come from private institutions (publishing houses, corporations) and only 2 were developed by government agencies. On the other side, the money for 40% of the projects came from public funds; 30% from private institutions; 16% from educative organizations and 14% from the combination of different sources.

An important thing we noticed with the information analysis is a clear imbalance in the PC of S&T model used: deficit is a clear leader with 35 strategies, dialogue shows a growing presence with 14 and there is only one case of public engagement. It must be highlighted that there are four books, a deficit oriented medium traditionally, in which authors prepared their material by interacting with different public sectors.

A review of the technical information compared to the social discussion of NT shows important features about the PC strategies. 47 products provide a medium or high level of the technical side, while for the social part only 8 provide a medium or high level of discussion. This is a clear indicator of the profile and interests of the people involved in the projects, prioritizing an understanding of the S&T elements associated to NT and, in the process, having almost no connection whatsoever with the social context that make this technologies possible.

The products in the study offer an optimistic perspective for the most part: 43 out of 50 reviewed strategies have a *possible advance* frame and four are in the *utopia* category; only two products insert themselves in a *generic risk* frame and there is only one with a *conflict* approach. All of this points to most strategies working more as nano-propaganda than as a foundation for an important social discussion process.

If we turn our attention to risks, a fundamental aspect for several social sectors, there are big disparities between the different projects. 60% of them completely ignore the issue (as it did not exist), while 14% have a marginal discussion about them and this leaves a 26% (13 cases) that offer a broader perspective of the implications of this emerging S&T system. But it is only in 5 cases (10%) that risk assessment has a relevant role in the communication strategy.

A key fact that relates to the previous points is that 43 projects were led by people with an education background in basic sciences or engineering (technical experts). This helps explain the low level of social discussion and complete hegemony of the technical approach in the PC of NT projects studied. On the same note, we found that half of the strategies leaders do research as their main professional activity and in 20 cases a professional science communicator was the leader (17 of them are in the United States). In Spain and Mexico PC efforts are still too dependent on the interest and effort put by researchers; there is a need for more participation from science communicators.

Researchers are fond to work with deficit type communication strategies while professional communicators show a more balanced tendency with a slight advantage for dialogue. This is logical considering a full time professional of PC of S&T knows the theoretical advantages of

dialogue compared to deficit and uses the latter only when the specific communication project requires so.

Finally we found that between 2002 and 2007 all of the strategies had a deficit type of communication, and it was in 2008 when dialogue efforts started gaining presence in the PC of NT in the studied countries. Also the number of products created each year seems to grow over the period of analysis. The growth we see in the number of strategies and in the diversity of PC models used shows a certain degree of maturing in the PC of NT.

Conclusions

Our analysis of public communication of nanotechnologies strategies in Mexico, Spain and the United States -through books, exhibits/workshops, and videos- show the prevalence of overly optimistic narratives that intend to secure social support for NT in general and the specific route chosen by researchers and government agencies. For the most part this comes in detriment of a balanced perspective in the communication process, reducing social issues –and risks specifically- to a minuscule or non-existent role.

So we found the vast majority of the projects are deficit oriented: authors decide what is relevant to the discussion and what is left out, while the interests and concerns of different social sectors are seldom considered. There is little participation of organizations outside S&T or government circles to promote a balanced discussion that includes both technical and social aspects of NT. Although important networks, such as the Nanoscale Informal Science Education Network (in the United States), pay attention to social aspects of this subject their frame seems limited by academia's and government's interests.

The strategies in the study are more of propaganda efforts for NT, and the consumption of nano products in the market, than benchmarks for an inclusive communication process that allows society to have a say in the route for nanotechnologies. In here, we see a need for citizens and, most of all, organized civil society to demand a more complete and open discussion and become an essential part of NT development.

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