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RESEARCH ARTICLE

# Promoting Scientific Culture: A Review of Public Policies in the Ibero-American Countries

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**Abstract**

The article presents an overview of a recent study aimed at describing how the efforts to improve the public scientific culture (SC) have gained ground in the broader frame of public policies for S&T in Ibero-America. The purpose is to assess to what extent the discourse of the governmental agencies reflects the concern over the matter and in which way the usual 'loud and clear´ claims in this sense turn into operative strategies, actions and tools. The outcomes suggest a complex scenario. Although most of the countries explicitly encompass the need to improve public engagement with science in their respective sectorial Plans, the interest put forth at this rethorical level doesn't always match with the type of (limited) actions actually carried on in a factual level. Besides, the huge heterogeneity of concepts, tools, practices and aims reported in each context as part of the promotion of scientific culture not only entails a difficulty to achieve a reliable picture of the regional policies in this field but, at the same time, hinders the possibility of a more accurate assessment and comparison among them.

**Keywords:** Scientific Culture, Communication, Popularization, Indicators, Policy

## Introduction

The fostering of a deeper public engagement with science and technology may be still considered a pendant issue in many

Ibero-American countries,[1] even in those that in recent years have increased their efforts to consolidate and expand their national systems of Science and Technology (hereinafter, S&T). In contexts where resources are limited and the needs abound, its prior allocation to satisfy what can be regarded as *basic demands* on this domain — the strengthening of the research and development capacities, the training of specialised human resources — is somehow foreseeable. That helps to understand, although not to justify, the marginal character frequently assigned in regulatory frameworks to the initiatives aimed at promoting the public scientific culture (SC) with respect to their overarching purposes.

However, this trend seems to be changing. With a few exceptions, and clear nuances in their ranges of commitment, the outcomes of the study we present suggest that most of the governments in the Ibero-American region have assumed that stimulating practices of social communication and appropriation of science is a relevant task that makes part and parcel of their S&T policies. Instead of an additional concern of little interest and even less resources, the need to narrow the gap between science and society is gaining space among the facets that make up a comprehensive approach of the production, application, transference and circulation of knowledge.

By adopting an active position in this realm, policy actions pursue different but related goals: to enhance the social approval and support for the investments in the area; to make visible the governmental efforts and its results; to promote more innovative and entrepreneurial cultures; to encourage scientific and technological vocations among the youngest; to develop a

[1] Ibero-America (all the Latin American countries plus Portugal and Spain) is a large region that encompasses many nations, cultures and languages where dominate Spanish and Portuguese. The region has similar historical circumstances but is also characterized by huge ecological and cultural diversity; extreme social stratification and differentiation; and very different macro-economic and political situations. The region plays a secondary role on S&T, but economic growth in Latin America in recent years revitalized S&T policies. For instance, over the recent past years, R&D investment grew faster than in Europe, USA and Canada, only behind Asia, and some areas like biotechnology or information technology have experienced a considerable expansion (RICYT, 2011).

critical public ready to participate in the debates around disputed issues related with science and technology (Felt, 2003; Gonçalves & Castro, 2003a; Chavot & Masseran, 2003; Valenduc & Vendramin, 2003; Department of Science and Technology, Republic of South Africa, 2014). Although its value oscillates between more 'economical' or more 'enlightening' purposes (Schiele, *et al*., 2011), the key role played by political authorities in the promotion of scientific culture, and their capacity to lead similar efforts among other social actors, seems to be nowadays out of discussion (Miller *et al.,* 2002).

## The Research Background and Design

The aforementioned appraisals are mostly focused on highly-developed countries, with well-established S&T systems and whose political agenda — yet with its peculiarities — echoes the suggestions made by supranational entities, such as those of the Organization for Cooperation and Economic Development (OECD) or the systematic plans of research and action regarding public awareness *about* and understanding *of* science launched by the European Commission. Less known are, thus far, the ongoing trends in this direction in other regions around the world.

In the framework of a much comprehensive study aimed at giving an overall picture of the *Practices and Values of the Social Communication of Science in Ibero-America*,[2] the survey we conducted comes to fill the void of information about the governments' attitudes and measures to promote the public appropriation of science in twenty-two country members of the Ibero-American States Organization (OEI for its acronym in Spanish): Argentina, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Chile, Dominican Republic, Ecuador, El Salvador, Spain, Guatemala, Republic of Equatorial Guinea, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Portugal, Uruguay and Venezuela. The key question was to determine how the issue is

[2] The project, co-chaired by the authors of this paper, is supported by the Observatory of Science, Technology and Society of the Organization of Ibero-American States (OEI). The final report will be soon available in Spanish and English at the Observatory web site: www.observatoriocts.org

addressed in the general scope of their respective S&T policies, with special focus in:

- The institutional structures at the national governmental level for coordinating the initiatives.[3]
- The rethorical level of the current sectorial laws and policy plans in each context.
- The practical level of the concrete actions promoted, supported and/or carried out by the public sector.

On the basis of the achieved repertoire of tools and practices, the overarching purposes of the research are to critically examine their underlying theoretical and practical assumptions — explicit or implicit in their goals and intentions — and to develop a preliminary set of indicators that allows to classify and assess them, in order to facilitate a more accurate comparison of the performances among the region.

With partially convergent aims, other institutions have embraced a somehow similar interest. In parallel with this work, a simultaneous survey conducted by the United Nations Organization for Education, Science and Culture (UNESCO) together with the Red-Pop[4] produced a detailed inventory of normative and instruments for the field.[5] A decade ago, a study developed in the framework of the country members of the Andrés Bello Convention[6] described the science popularisation experiences in those contexts (Lozano, 2005).

A compelling question acknowledged by every project on the subject is the broad diversity of notions used to refer to the common concern about the awareness and knowledge of science by the public (Felt, 2003; Gonçalves & Castro, 2003; Department of Science and Technology, 2014). The ubiquitous

[3] Neither provincial nor municipal governmental initiatives were covered in this opportunity.

[4] Red-Pop is a network that congregates centers and programs for the popularization of science and technology in Latin American and the Caribbean.

[5] Its results are available at the UNESCO's platform of information about scientific policies in Latin America and the Caribbean - *SPIN*. URL: http://spin.unesco.org.uy/

[6] The countries analysed in that opportunity were: Bolivia, Chile, Colombia, Cuba, Ecuador, España, Panama, Paraguay, Peru and Venezuela.

character of expressions such as public 'awareness'/ 'understanding' / 'appropriation' / 'engagement' *of* and *with* science and technology, scientific 'literacy' / 'culture', makes difficult to guess up to what extent the appealing to certain words indicates a deliberately adopted stance or just a pragmatic use. In addition, the related terms of 'science communication', 'popularisation' or 'dissemination' of knowledge are also used as synonyms.

It is unfeasible to do justice in this context to the host of issues raised around those expressions — each of them with own epistemological, theoretical and practical assumptions. However, in order to briefly set the scene, this study takes 'scientific culture' as a comprehensive notion in two senses: firstly, as a concept that reflects 'a society-wide environment that appreciates and supports science and scientific literacy' (O'Connor & Stocklmayer, 2003: 190), the general entourage that facilitates and makes sense of practices tending to promote awareness, understanding, involvement and literacy. Secondly, as the all-encompassing expression 'of all the modes through which individuals and society appropriate science and technology' (Godin & Gingras, 2000: 44), including among those modes the initiatives encouraged by governmental agencies.

To be consistent, our study adopted a *naturalistic* methodological approach, enlisting the broad panoply of actions that in each setting were considered part of the strategies in the pursuit of the general goal of bringing science and technology closer to people. After identifying the main public agency(ies) responsible for the sectorial policies in each country, a first phase of the survey (August-December 2013) was focused on:

1. A content analysis of the current laws and National Plans for S&T,[7] aimed at detecting every mention related with keywords such as scientific culture; scientific literacy; public awareness/understanding/engagement with science; social appropriation of knowledge; science communication; popularisation and the like.

[7] See the list of analyzed laws and documents in the references.

2. An exhaustive exam of the respective websites of the involved agencies — and other relevant links when proceeded — in order to register and preliminary classify every program, project, tool and activity, promoted, financed and/or managed by them, comprised under the same labels.

In the second phase — January-July, 2014 — the data was updated and checked with the help of local informants, and a more robust set of classification criteria was developed.

## Results and Discussion

### *The Institutional Structures and the Discursive Level*

Some degree of attention regarding the promotion of the public scientific culture was identified in nineteen out of twenty-two of the examined countries — all the above mentioned with the exceptions of Equatorial Guinea, Honduras and Nicaragua. That interest is reflected in: (a) the explicit references to the topic in the framework laws and/or sectorial plans (seventeen cases); (b) the existence of a governmental unit in charge of the issue (eleven cases); (c) the development of concrete actions (eighteen cases). These variables are not always concurrent: mentions in policy documents do not necessarily imply actual practices; nor the opposite, its absence, indicates lack of activities.

The framework laws for S&T usually refers to scientific culture in a shallow or generic way among the objectives, functions and competences of the system's agencies or plans, in terms of 'to popularise', 'to transfer', 'to promote' or 'to communicate' knowledge. However, in countries like Colombia, Spain, Mexico or Peru, laws are full of very detailed references to the close relation between its improvement and the potential success of the sectorial policies and the countries development.

Among the current sectorial Plans the topic is explicitly mentioned in seventeen cases, literally expressed in terms of 'scientific culture' and/or through the varied range of denominations already described. In this wide semantic field, concepts are indistinctively used in the policy documents to refer both to the ends and the means of the social flowing of scientific knowledge, as table 1 summarises.

Table 1 — References About And Related With 'Scientific Culture' in Policy Documents

| Ends | Means |
| --- | --- |
| **Appropriation:** social, public, collective; of science; of science and technology; of scientific knowledge; of scientific and technological knowledge (9 cases). | **Diffusion, Dissemination, Communication:** social, public; of science; of science and technology; of scientific knowledge (13 cases). |
| **Scientific Culture** (9 cases). | **Popularization:** of science; of science and technology; of science, technology and innovation; of knowledge (9 cases). |
| **Other Terms:** social appreciation of science, technology and innovation (1 case); visibility of science (1 case); scientific literacy (1 case); public awareness (1 case). | **Other Terms:** socialization of knowledge (4 cases). |

Given that the documents are structured in diverse ways, to compare the hierarchy assigned to the topic in each case is a complex task. The analysis is also restricted to its contents, since details about the budgetary amounts allocated to the issue are not provided — the kind of information that would help to achieve an accurate idea of the matching between the rhetorical assertions and the investments needed to concrete them. However, a set of relevant features can be detected:

- Despite their peculiarities, a handful of common concerns cut across almost all the documents analysed. In every context the promotion of scientific culture is strongly tied with its potential impact in the awakening and encouraging of scientific and technological vocations among young people — what is consistent with the amount of activities dedicated to this specific audience. Another shared characteristic is the all along appealing to the argument of enabling the public participation in policy issues regarding science and technology as one of the main purposes to be attained — although the actions in this sense represent just the 2 percent of the total. Thirdly, every document emphasizes the effects of a widespread scientific culture on the improvement of the innovative capacities of the countries.

- The National Plans of Colombia and Mexico include a detailed analysis of the collective appropriation of science in each context as a previous step towards the formulation of measures. Both countries also call the attention to the enhancement of the public scientific culture as a precondition of their respective plans' success and, in general, of the pursuit of national development. Brazil and Spain do the same, by incorporating the topic among the priorities that structure their policies.

- The Venezuelan document goes in a similar direction, adding an ideological nuance. The issue is integrated in a wider frame of debate about the need to reach an endogenous development, in which the social appropriation of knowledge is straightforwardly linked with the empowerment of the nation's research and development capacities

- As part of the strategies designed to accomplish a more comprehensive and diversified developmental pattern, Bolivia includes the goal to create an *inclusive* scientific culture with vernacular attributes. A wide, well-detailed Popularisation Program is proposed consequently, although its achievements thus far could not be assessed beyond the five actions identified in the country.

- Dominican Republic, Guatemala and Chile represent the opposite poles of the relationship between the rethorical interest reflected in the policy documents and the current actions. In the Caribbean nations, the former abounds in extensive and in-depth references to the importance of the popularisation and appropriation of science, although not a single action was found in the case of Dominican Republic and just a few in Guatemala. Chile, on its part, has one of the most renowned programs for scientific culture in the region — *Programa Explora* — even when the issue as such is not a highlight in its policy documents.

### *Tools and Activities*

Eighteen of the surveyed countries present at least one initiative in the domain of scientific culture, broadly speaking, promoted by a national governmental agency.[8] The approximate total number brings to one hundred and sixty-eight actions, encompassing a wide range that goes from: a) countries with fifteen and more instances (Spain, Portugal, Chile, Argentina, Brazil); b) countries with ten to fourteen instances (Mexico, Colombia and Costa Rica); c) countries with five to nine instances (Venezuela, Uruguay, Panama, Bolivia, Guatemala and Peru); d) countries with less than five instances (Cuba, Paraguay, Ecuador, El Salvador).

These figures must be cautiously interpreted. As we just pointed out, nations at the Ibero-American region present noticeable differences regarding their social, cultural and economical features, as well as in their levels of general development, problems and challenges. Realities are also uneven in terms of each context's research capacities, investments in the area and degrees of articulation of the respective National Science and Technology Systems.[9] That implies a basic conditioning that must be acknowledged when assessing the interest in scientific culture and its varied degrees of concretion.

[8] Before going into details, it must be acknowledged that science museums of any kind -both the generic and the disciplinary ones - were deliberately excluded from the scope of application of the survey, due to substantial and pragmatic reasons. In the first place, the analytical unit of our study were the national agencies as the institutions that lead and encompass the surveyed practices, while museums are institutions in themselves which, in turn, develop their own parallel and -most of the times- independent actions. Secondly, with a few exceptions -such as the National Science Museum in Spain- is not always easy to identify unequivocally the dependency status of the numerous generic or disciplinary museums in the region: some of them are embedded in complex inter-institutional networks of budgetary agencies; others belong to universities, foundations or private organizations; and others depend upon provincial or local governments. In the light of all of this, we assume that science museums are distinctive agents which peculiarities and would deserve a specific in-depth approach that goes far behind the limits and aims of this study.

[9] See the selected comparative indicators in the Appendix and, also alternatively, the 2014 report on *The State of Science* elaborated by RICYT (http://www.ricyt.org/publicaciones).

Besides, naïve comparisons must also be avoided taking into account that the publicly available information only refers to the number of activities and not to other more useful data -such as allocated budgets, number of attendants to the main activities, or the audiences effectively reached by different means. As it will be highlighted in the concluding remarks, to generate indicators is a certainly compelling task in order to achieve a more exact comparison among the countries in the region and move on more comprehensive cross-sectional studies.

As it was mentioned, the survey proceeded without adopting an *a priori* normative stance, intending to grasp what the agents' own criteria considered related with the fostering of scientific culture. After an inductive analysis of the information, the heterogeneous repertoire of practices obtained was systematized according to a matrix of criteria and categories aimed at classifying the initiatives regarding four relevant aspects: (a) their modalities; (b) the degree of involvement of the public agency in their concretion; (c) their explicit or inferable intentions; (c) the main target audience(s).

### *Type of Action according to its Modality*

The indicator points out to determine the intrinsic manner assumed by the initiatives. As Table 2 shows, they can be roughly grouped in three levels.

#### *Level 1*

Awards and contests and the organization of events are the most frequent types of actions detected; taken together they constitute almost half per cent of the total. The former includes prizes to science journalism, incentives to invention and innovation, as well as several contests — photography, paintings, audiovisual products, essays and other literary genres — linked to scientific topics. Brazil, Argentina and Portugal are active in this category. Events are present in almost every country with diverse forms: Science Cafés, Exhibitions and Fairs; Round Tables; Conference Cycles; Meetings and Seminars. The National Science Week — following a standard format of popularisation and pedagogical-educative activities — is probably the most extended instance of its kind in the region, permanently settled in eleven countries.

Table 2 — Governmental Initiatives for Scientific Culture in Ibero-American Countries

| **Indicators** | **Categories** | **% (*n*=168)** |
|---|---|---|
| **(I) Modality** | 1. Awards and contests | 24% |
| | 2. Events | 23% |
| | 3. School activities | 15% |
| | 4. Products and media for science communication | 15% |
| | 5. Competitive funds | 8% |
| | 6. Perception surveys | 7% |
| | 7. Others | 8% |
| | **Total** | **100%** |
| **(II) Involvement of the Governmental Agency** | 1. Collaborative | 55% |
| | 2. Direct | 37% |
| | 3. Indirect | 8% |
| | **Total** | **100%** |
| **(III) Intentionality*** | 1.Popularization of knowledge | 44% |
| | 2. Pedagogical-Educative | 35% |
| | 3. Promotion of human resources in scientific communication and culture | 17% |
| | 4. Research | 8% |
| | 5. Public hearing and participation | 2% |
| | 6. Others | 9% |
| | **Total** | **100%** |
| **(IV) Target Audiences** | 1. General | 36% |
| | 2. Children and adolescents | 21% |
| | 3. Diverse audiences | 17% |
| | 4. Scientific institutions and communities | 11% |
| | 5. Journalists, content producers | 9% |
| | 6. Minorities | 3% |
| | 7. Scholar students | 1% |
| | 8. Not possible to identify | 2% |
| | **Total** | **100%** |

* Activities can have more than one intention, thus percentages exceed the 100%. Project *Practices and Values of the Social Communication of Science in Ibero-America* (Observatory STS, OEI).

*Level 2*

School activities and own elaborated products for science communication and culture appear with similar degree of frequency. The former articulate the governmental areas and educational institutions, with the [most of the times] explicit aim of attracting children and teenagers to science and technology. The encouraging of scientific vocations drives broad initiatives designed to support science teaching and foster new pedagogical approaches — the Portuguese Ciência *Viva*, the Colombian *Ondas* and the Chilean *Programa Explora* are the flagships programs in this sense — as well as concrete actions like Science Clubs or Camps and disciplinary Olympiads. On the other hand, some agencies produce science communication resources and materials or even run their own broadcasters — as the *Spanish Foundation for Science and Technology TV* (*FECYT TV)* in Spain, *Ciência Viva TV* in Portugal, *ConCiencia TV* in Venezuela and the recently created *TEC-TV* in Argentina. The FECYT opened a new path in this direction by launching in 2008 the first official scientific news agency in Ibero-America: the Service of Information and Scientific News (SINC).

*Level 3*

Finally, with lower incidence in the total amount of actions are public funding for projects selected following competitive calls — more common in countries with strong track records in science policies like Brazil, Chile, Colombia, Spain, Mexico and Portugal — and surveys on public perception of science and technology. The latter, considered amongst the most relevant instruments for policy making in the domain of scientific culture, present a dissimilar path in the region. By the year 2000, when RICYT and OEI launched the first Ibero-American project on public perceptions of S&T, there were few countries with nationally representative surveys on PUS (Brazil, Mexico and Panama). Just over one decade later, the conditions visibly changed: a good amount of large-scale surveys have been conducted by many countries. In some countries these studies have begun to be carried out periodically — Argentina, Brazil, Mexico or Spain — but in other cases just eventually — Portugal, Ecuador or Costa Rica (The Antigua Manual, RICYT, 2015). Additionally, some cross-sectional surveys on scientific culture were also conducted (FECYT, OEI, RICYT, 2009; Polino, 2011).

### *Type of Action according to the Involvement of the Governmental Agency*

The enhancement of scientific culture is not — or at least, it should not be — only a concern for the public sector but for a broader set of agents as well: educational and cultural institutions, the media, the academic and scientific communities, non-governmental organizations and alike. The assemblage of efforts from different sectors is valuable for a number of reasons. First, it entails the need to discuss and reach basic agreements on the interests, objectives and meaning assigned to the task. Besides, it allows to optimise the action planning, avoiding duplications and overlapping, and to take advantage of the variety of expertises and capacities provided by the participants.

As Table 2 shows, this is the case of more than half of the actions, in which the official entity works cooperatively with educative and/or scientific institutions, other governmental agencies, other national or international institutions, or as part of collaborative networks that gather several organisms. The data suggests a good willingness on the part of the public sector to cooperate with other agents with similar interests and capacities. Besides, consistently with the fact that pedagogical-educative activities are the most numerous, it is not surprising that partnerships usually involve educational or scientific institutions.

Under the label of Direct Actions (37 percent) were included all those that do not involve any type of partnerships but are funded and executed solely by the official department — mainly the own media and products, the surveys and most of the awards and contests. Finally, in the remaining 8 percent of actions the participation of the governmental agency is only indirect, limited to promote and/or support external proposals — in this case, public funding for projects selected following competitive calls are the most characteristic practices.

### *Type of Action according to its Intentionality*

The evidence gathered reveals not only a variety in the action's modalities but also in their motivations. These are particularly relevant for different reasons. Firstly, by analysing them it is possible to infer the implicit concept of what is *scientific culture* and its relation with the different mechanisms through which it may be promoted — popularisation, formal education, knowledge transfer. Secondly, policymakers are presumably *intentional* agents, ready to choose the most appropriate actions as means to reach their goals. Therefore, the strategies adopted should be closely related with the former and, at the same time, linked with the normative queries that underlie different perspectives about scientific culture. Why should governments be committed with its expansion? What's the ultimate meaning to foster it: to spread knowledge, to encourage scientific vocations, to increase the public support for the S&T development, to favour a plainer dialogue between science and society, to achieve committed, critical and participative citizens aware of their rights and responsibilities?

These questions lead us to an evaluative dimension, not enough explored yet, that must be approached both in an intrinsic level — the quality assessment of actions in itself — and in an extrinsic one — its adequacy to reach the foreseen goals. Which parameters are needed to address each aspect? Ultimately, are the resources allocated to promote scientific culture well or wrongly applied? How can that be properly judged? Although we are not ready to actually solve this puzzle, the proposed criteria of intentionality can be a fruitful step in this sense.

The first set of actions, motivated by popularisation purposes (44 percent), makes up a pattern repeated throughout the countries that reflects an orientation anchored in the idea that achieving scientific culture has to do directly with the spread of information. This emphasis in popularisation, that clearly mirrors the suggestions of the classical 'deficit model', pervades different modalities of actions. A second nucleus aggregates activities related with the improvement of science teaching and the increasing of children and adolescents interest in scientific matters and careers (35 percent). Its official support are most of the times explicitly referred as part of the more global effort devoted to achieve a critical mass of trained human resources able to lead the scientific and technological development of the country.[10] Taking both indicators together, almost eight out of ten governmental initiatives in the domain of scientific culture have to do directly with the spread of scientific knowledge either through popularisation or the mechanisms provided by educative institutions.

A third type of actions tend to foster human resources in the area through different measures: the sponsorship of training courses or professional meetings, scholarships, awards to science journalists or media, among the most frequent. Fourteen of eighteen countries develop at least one activity with this goal. Lastly, after public perception surveys and other specific research initiatives, at the bottom of the ranking appears a negligible percent of actions devoted to promote the citizen's participation in public discussions about science and technology or their involvement in collaborative process of knowledge construction. This scarcity in the governmental agendas sharply contrasts with the relevance given to this kind of actions in the current academic debates, as a result of the transition from the deficit model to others that explicitly acknowledge its value to boost the public's engagement.

### *Type of Actions according to the Target Audience(S)*

Which are the most *interesting* or relevant public(s) that official agencies have in mind when drawing their strategies for spreading scientific culture? Are minorities such as the elderly, disabled people, indigenous population, among others, sufficiently taken into account in their plans?

The target publics mainly addressed are consistent with the action's intentionality described in the previous section. Thus, at

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[10] In many cases, underlying this kind of educational initiatives is the purpose to replace an overly 'theoretical-focused' science teaching for other more 'hands-on' approaches, based on direct experimentation and manipulation. Despite its good intentions, sometimes these efforts lead to the unintended consequence of setting a sharply limited idea of science as something that solely occurs at labs — reinforcing among the young the status of experimental disciplines such as physics, chemistry and biology at the expense of others non-experimental disciplines and, by doing this, deepening the gap between the 'two cultures' instead of helping to solve it (Gonçalves y Castro (2003b: 87).

the top list ranks the general, most of the times undefined, audience that corresponds to popularisation initiatives; secondly, children and teenagers to whom educational activities are dedicated. Two in ten actions are focused in specific groups, such as the scientific community or content producers, while others -for instance, events like Science Fairs or Weeks- appeal to diverse publics. Among the total number, only one action targeting a group with disabilities was identified: the National Science Project of Sign Language, a cooperative initiative managed by the Venezuelan governmental unit along with academic institutions and non-governmental organisations.

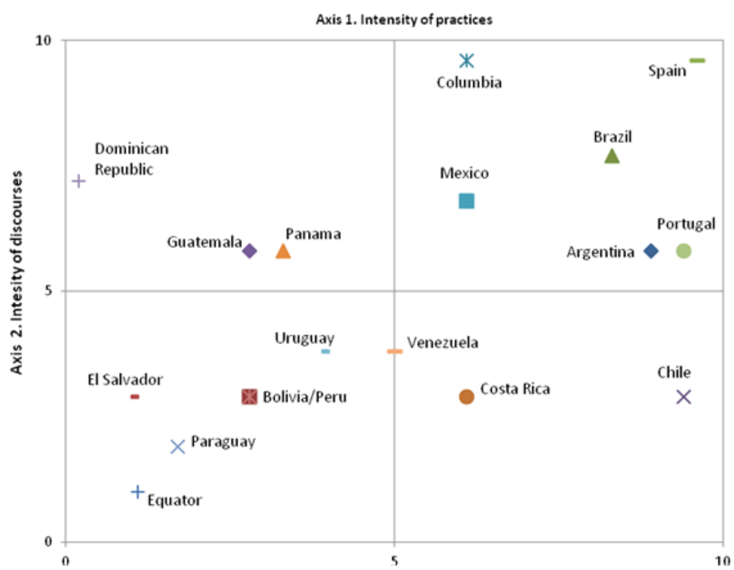
### *Discourses and Practices*

Keeping in mind the already settled *caveats* regarding the feasibility of an accurate comparison among the countries, the chart 1 tends to depict the relationship between the level of interest in the promotion of scientific culture expressed in the policies documents and the mode in which this concern turns into concrete practices. The vertical axis represents the attention dedicated to scientific culture at the rethorical level. The ranking of the countries on this factor is based on a summated index that comprises three indicators which define the hierarchy given to SC by policy documents: first, whether the references to SC in laws are strong ('1'), weak ('.5') or missing ('0'). Second, whether SC is explicitly defined ('1') or not ('0') as a basic condition for S&T systems performance and its integration with society. Third, the salience of SC as a domain of first ('1'), second ('.5') or third ('.25') order of magnitude.[11] The index was normalized to their values range between '0' (minimum discursive intensity) and '10' (maximum discursive intensity) as

[11] We defined the orders of magnitude as follows: 1) "first order", SC is conceived as a specific and independent component in the framework of the sectorial policy. SC is a domain equivalent to other "priority areas" with detailed goals, objectives, instruments and linkages with other sectorial components; 2) "second order", SC originates a differentiated and specific program with differential degrees of political institutionalization, internal consistency and coordination with other strategic actions; 3) "third order", SC is only referenced in policy documents, more or less significant depending on the case.

it is projected on the chart. At turn, the horizontal axis reflects the dynamics of SC in terms of intensity of practices. It reflects the total number of activities (n = 168, Table 2) distributed by country.[12] Also this variable was normalized to their values oscillates between '0' (minimum intensity of practices) and '10' (maximum intensity of practice). Although this classification is based on a qualitative approach to the examined phenomenon, we consider it useful to represent how the countries seem to be distributed with respect to their performance in terms of practices and discourses.

Chart 1 — Distribution of the countries according to practices and discourses on Scientific Culture




As the graphical representation shows, it is possible to identify different realities depending on the countries in question. A first group of countries, comprised by Spain, Brazil, Argentina, Portugal, Colombia and Mexico, appears to be the more dynamic in the promotion and the institutionalization of the

[12] Total number of activities by country: Spain, 23; Portugal, 17; Chile, 17; Argentina, 16; Brazil, 15; Mexico, 11; Columbia, 11; Costa Rica, 11; Venezuela, 9; Uruguay, 7; Panama, 6; Bolivia, 5; Guatemala, 5; Peru, 5; Cuba, 4; Paraguay, 3; Ecuador, 2; El Salvador, 1.

scientific culture. Despite their differences, these countries have consolidated their institutional practices and incorporated this topic into the public agenda. In opposition, another group is made up by countries where scientific culture is less institutionalized in both domains. However, there also are remarkable differences among them: see, for instance, the salience of Uruguay in comparison with El Salvador, Equator or Paraguay. The third group of countries would correspond mainly to the cases of Chile (one of the most dynamic countries in producing science communication materials) and Costa Rica where practices seem to be more significant than the rethorical domain. Finally, the fourth group (Dominican Republic, Guatemala and Panama), have given magnitude to the policy declaration on the importance of the scientific culture for the national performance even though the intensity of practices is lower than in the other contexts.

## Conclusion

Public communication is today an essential need for researchers and scientific organizations. The search for visibility, legitimization, funding, and the need of negotiations and dialogue with different stakeholders, generate new impulses for science communication practices. In this context, governmental and scientific institutions believe the importance of improving scientific culture in society (knowledge, interest, and positive attitudes) and different social institutions, academic groups and stakeholders also emphasize information and scientific culture must be the basis for citizen participation and the democratization of decision-making in science and technology. Therefore, public policies face the challenge of stimulating scientific culture in a context of dialogue, civic participation and social inclusion.

Our research allowed us to identify factors associated to a process of institutionalization of scientific culture initiatives associated with the consolidation (or emergency) in the last decade of standardized practices expressed through indicators such as regularity of activities, creation of units and institutions of education and training, formation of specific roles, processes of professionalization (of scientists as communicators, in the field of science journalism, public relations, etc.), resource allocation, evaluation systems, and so on. Thus, the results reflect some substantial coincidences among the analysed countries. A relevant key point is practically all the current policy documents explicitly refer to the topic of scientific communication or culture — although with clear nuances in the relevance assigned, the terms used and the proposed objectives — conferring the issue an unprecedented legitimating feature. Another remarkable issue is S&T agencies have also developed a quite relevant number of differentiated initiatives (national awards, science weeks, science festivals, popularization activities, school activities, and so on) based, in some cases, on an important historical background, where is possible to differentiate specific goals, scopes and publics. However, another common feature is the lack of empirical information, data or indicators to evaluate, for instance, the human and economic resources allocated by the national agencies to promote scientific culture practices. Hence, at large, the impact evaluation is still not common and a very complicated technical issue.

Nevertheless, our research also put in evidence that despite the existence of common trends and communalities, the countries are heterogeneous (even considering the terms and concepts sometimes used to describe the activities conducted, not always comparable) and exhibits different patterns both in terms of discursive strategies and practices. In this line, it seems the more developed the country is in terms of S&T structures and salience, the more relevant have turn out the activities related to scientific culture.[13] In addition, in accordance with the depiction made by Polino & Castelfranchi (2012) for science communication practices in the region, our evidence also suggests that in the countries where national S&T systems have grown faster (Argentina, Brazil, Colombia and Mexico),

[13] Considering only Latin America, Brazil, Mexico and Argentina are responsible for most of the regional expansion in S&T: they contributed more than 80% of regional S&T investment. Together, these three countries accounted for over 85% of the total number of the regional researchers (RICYT 2011).

scientific culture and public policies have also increased in size and relevance.

Finally, further analysis should move towards the delimitation of an empirical research agenda which should take into account the discussion on the objectives of promoting scientific culture; on the coherence among the ends, the strategies and the promoted content; on the used terms, concepts and categories; and on the production of comparable indicators with respect to quality and impact for strengthening public policies and public engagement.

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# APPENDIX

| Comparative selected indicators by country | Argentina | Bolivia | Brazil | Chile | Columbia | Costa Rica | Cuba | Dom. Republic | El Salvador | Equator |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| **Population (million people) (year: 2012)** | 41.02 | 10.62 | 196.9 | 17.40 | 46.58 | 4.80 | 11.2 | 10.27 | 6.2 | 15.49 |
| | | | | | | | | | | |
| **Life expectancy at birth (years) (source: Unesco, 2008)** | 75.3 | - | 65.6 | 78.6 | 73.3 | - | - | - | - | - |
| | | | | | | | | | | |
| **GNP per capita - ppp U$S (source: World Bank, 2007)** | 13.800 | | 8.140 | ##### | #### | | | | | |
| | | | | | | | | | | |
| **Human Development Index (HDI) (source PNUD, 2007)** | .866 | | .813 | .878 | .807 | | | | | |
| | | | | | | | | | | |
| **Expenditure on R&D as % of GDP (year: 2012)** | 0.58% | .15%* | 1.23% | 0.35% | 0.21% | 0.47%** | 0.41% | | 0.03% | 0.34%** |
| *** last available year, 2009.** | | | | | | | | | | |
| **** last available year, 2011.** | | | | | | | | | | |
| | | | | | | | | | | |
| **Expenditure on R&D by funding source (year:2012)** | | * | | | | ** | | | | ** |
| **Government** | 74% | 58.9% | 54.9% | 37.1% | 41.9% | 70.3% | 79.9% | | 11.6% | 67.9% |
| **Enterprises** | 21.3% | 5.9% | 43% | 32.9% | 34.1% | 21.3% | 15% | | 2.7% | 0.9% |
| **Higher Education** | 3.1% | 30.5% | 1.9% | 9.7% | 16.3% | | | | 73.8% | 19.3% |
| **Non-profit organizations** | 0.9% | 2.36% | | 2.1% | 4.9% | 0.8% | | | 2.6% | 1.1% |
| **Foreign** | 0.58% | 2.13% | | 18% | 2.4% | 7.4% | | | 9% | 10.6% |
| *** last available year, 2009.** | | | | | | | | | | |
| **** last available year, 2011.** | | | | | | | | | | |
| | | | | | | | | | | |
| **Expenditure on S&T by type of activity (year: 2012)** | | * | | | | ** | | | | ** |
| **Basic research** | 33.9% | 70.4% | | | | 11.5% | 12.9% | | | 16.3% |
| **Applied research** | 43.8% | 23.4% | | | | 49.2% | 47% | | | 74.9% |
| **Experimental development** | 22.1% | 6.1% | | | | 39.2% | 39.9% | | | 8.7% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| * last available year, 2009. | | | | | | | | | | |
| ** last available year, 2011. | | | | | | | | | | |
| *** last year available, 2006 | | | | | | | | | | |
| | | * | * | | | ** | | | | ** |
| **Researchers (full-time) (year: 2012)** | 37946 | 1367 | 106359 | 6803 | #### | 6107 | | | | 2543 |
| * last year available, 2010 | | | | | | | | | | |
| ** last available year, 2011. | | | | | | | | | | |
| *** last year available, 2007 | | | | | | | | | | |
| | | * | * | | | ** | | | | ** |
| **Researchers (full-time) per 1000 labour force (year: 2012)** | 3% | 0.3% | 1.4% | 0.8% | 0.3% | 2.9% | | | | 0.4% |
| * last year available, 2010 | | | | | | | | | | |
| ** last available year, 2011. | | | | | | | | | | |
| *** last year available, 2007 | | | | | | | | | | |
| | | | | | | | | | | |
| **Granted patents (year: 2012)** | | | | ** | | ** | | | | |
| **Residents** | 163 | | 654 | 104 | 105 | 1 | 9 | | 10 | |
| **Not residents** | 769 | | 2476 | 909 | #### | 36 | 75 | | 38 | |
| **Total** | 932 | | 3130 | 1013 | #### | 37 | 84 | | 48 | |
| * last available year, 2009. | | | | | | | | | | |
| ** last available year, 2011. | | | | | | | | | | |
| *** last available year, 2008 | | | | | | | | | | |
| | | | | | | | | | | |
| **Papers in Science Citation Index (SCI) (year: 2012)** | 9835 | | 42135 | 6328 | #### | 475 | 930 | 104 | | 468 |

APPENDIX — *Contd.*

| Comparative selected indicators by country | Guatemala | Mexico | Panama | Paraguay | Peru | Portugal | Spain | Uruguay | Venezuela | Iberoamerica | United States |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Population (million people) (year: 2012) | 15.1 | 117.1 | 3.8 | 6.6 | 29.98 | 3.65 | 47.26 | 3.3 | 29.95 | 641.77 | 314.27 |
| Life expectancy at birth (years) (source: Unesco, 2008) | - | - | 73 | - | - | 77.9 | 80.1 | - | - | - | 77.9 |
| GNP per capita - ppp U$S (source: World Bank, 2007) | | | 7.050 | | | 15.370 | 17.830 | | | | 31.600 |
| Human Development Index (HDI) (source PNUD, 2007) | | | .840 | | | .909 | .955 | | | | .956 |
| Expenditure on R&D as % of GDP (year: 2012) | 0.04% | 0.43% | 0.18%** | 0.08% | | 1.52%** | 1.30% | .24% | | .87% | 2.78% |
| * last available year, 2009. | | | | | | | | | | | |
| ** last available year, 2011. | | | | | | | | | | | |
| Expenditure on R&D by funding source (year:2012) | | | ** | | | ** | | | | | |
| Government | 23.5% | 60.8% | 46.7% | 84.5% | | 41.8% | 43.1% | 32.9% | | 50% | 30.6% |
| Enterprises | | 35.6% | 18.8% | 0.8% | | 44% | 45.6% | 15% | | 40.8% | 62.9% |
| Higher Education | 27.47% | 1.8% | 4.9% | 3.8% | | 6.2% | 3.9% | 43.4% | | 3.9% | 2.9% |
| Non-profit organizations | | 0.8% | 8.6% | 2.9% | | 2% | 0.6% | .9% | | 0.6% | 3.3% |
| Foreign | 49% | 0.8% | 20.7% | 7.8% | | 5.8% | 6.6% | 7.6% | | 4.5% | |
| * last available year, 2009. | | | | | | | | | | | |
| ** last available year, 2011. | | | | | | | | | | | |
| Expenditure on S&T by type of activity (year: 2012) | | | ** | | | ** | | *** | | | ** |
| Basic research | 6.4% | | 21.9% | 11.8% | | 20% | 23% | 21.2% | | | 17.3% |
| Applied research | 91.3% | | 41.4% | 71.1% | | 38.7% | 41.3% | 65.2% | | | 19.2% |
| Experimental development | 2.2% | | 36.6% | 16.9% | | 41.1% | 35.6% | 13.4% | | | 63.4% |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| * last available year, 2009. | | | | | | | | | | | |
| ** last available year, 2011. | | | | | | | | | | | |
| *** last year available, 2006 | | | | | | | | | | | |
| | | | ** | | | ** | | | ** | | *** |
| Researchers (full-time) (year: 2012) | 411 | 43592 | 438 | 970 | | 50070 | 1E+05 | 1825 | 6720 | #### | 1E+06 |
| * last year available, 2010 | | | | | | | | | | | |
| ** last available year, 2011. | | | | | | | | | | | |
| *** last year available, 2007 | | | | | | | | | | | |
| | | | | | | ** | | | ** | | *** |
| Researchers (full-time) per 1000 labour force (year: 2012) | 0.06% | .8% | | 0.3% | | 9.1% | 5.4% | 1% | 0.4% | | 9.1% |
| * last year available, 2010 | | | | | | | | | | | |
| ** last available year, 2011. | | | | | | | | | | | |
| *** last year available, 2007 | | | | | | | | | | | |
| | | | | | | | | | | | |
| Granted patents (year: 2012) | | | *** | | ** | | | | | | ** |
| Residents | 7 | 281 | 13 | 4 | 9 | | 2542 | 4 | | 4036 | 108626 |
| Not residents | 38 | 12049 | 345 | 1 | 376 | | | 21 | | #### | 115879 |
| Total | 45 | 12330 | 358 | 5 | 385 | | 2542 | 25 | | #### | 224505 |
| * last available year, 2009. | | | | | | | | | | | |
| ** last available year, 2011. | | | | | | | | | | | |
| *** last available year, 2008 | | | | | | | | | | | |
| | | | | | | | | | | | |
| Papers in Science Citation Index (SCI) (year: 2012) | 170 | 11624 | 512 | 84 | 388 | 13962 | 60766 | 696 | 1154 | #### | 459112 |