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The spiral of scientific culture and cultural well-being: Brazil and Ibero-America

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The set of factors, events and actions of mankind in the social processes dedicated to the production the dissemination, the teaching and the publication of scientific knowledge constitutes the conditions for the development of a particular type of culture, quite commonplace in the contemporary world, which may be called *scientific culture*. In this article, we intend to present the representation of the dynamics of this area of knowledge in the form of a spiral: *The Spiral of Scientific Culture*. Also, we introduce the term *cultural well-being* – the kind of comfort, other than the social well-being, which has to do with society's relationships with the technosciences, involving values and attitudes, habits and information, and presupposing an actively critical participation on the part of that society in the totality of these relationships.

Keywords: cultural well-being, scientific culture, scientific culture indicators, spiral of scientific culture

1. Scientific culture

The set of factors, events and actions of mankind in the social processes dedicated to the production, the dissemination, the teaching and the publication of scientific knowledge constitutes the conditions for the development of a particular type of culture, quite commonplace in the contemporary world, which may be called *scientific culture*.

To seek to characterize an Ibero-American space of knowledge constitutes also a theoretical-methodological endeavor making it possible at the same time to organize it and represent it in such a way that, in that representation, it is possible to see, among other things, the dynamic of the processes of production, dissemination and publication of knowledge, that is to say, the very dynamic of scientific culture itself in that space.

The dynamic of this space of knowledge expressed as a specific scientific culture may be represented in the shape of a spiral. By tracking the development of science through the institutions dedicated to its practice and production, the spiral contributes to a visualization and understanding of the common elements that exist and, thus, to a definition of what in these pages we term the Ibero-American space of knowledge. More specifically, in this context of the space of knowledge, this article seeks to place emphasis on Latin America and, in particular, on Brazil.

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In this sense, the *spiral of scientific culture*,[1] as I propose to call it, is a metaphor which, as will be seen later in this article, seeks to relate institutional facts and events common to different countries of Ibero-America, and coincidental in time. When arranged in the spiraled movement of the figure, these highlight points and trace a path that will serve for the delineation of the cultural space that conceptually encompasses the dynamic of knowledge in Ibero-America.

The graphic representation of facts related to the activities of scientific and technological research in Brazil and in the countries of Latin America, such as founding dates of actors, museums, agencies etc., related to the institutionalization of science, is an exercise of synthesis. If surveyed from the start of the post-Second World War period, when a greater intensity and organization of Brazilian and Ibero-American production in the area began to emerge, these facts stimulate interesting reflections on the constitution of the Science and Technology system.

In fact, it was the reverse path that led to the formulation of the spiral conceit as a way of understanding the acquisition of scientific culture, which originated in the production and dissemination of science among scientists. In this metaphorical image, knowledge reaches students of every level through their teachers and through the researchers themselves, continues to be disseminated in teaching for science – now involving science centers and museums, which reach broader and more heterogeneous publics – to finally, strengthen the specialization in scientific publication, practiced by journalists and scientists. Progressively, the evolution of the *spiral of scientific culture* continues through time and space and still produces, through the concatenation of actions and through the natural expansion of social participation, organisms which regulate the functioning of the system of science, technology and innovation (S,T&I). These are represented, for example, by normative commissions and advisory boards in different spheres of public power.

When we speak of "scientific culture" it is necessary to understand at least three possibilities of meaning which are offered by the very linguistic structure of the expression:

1. **Culture of science**
Here it is possible to distinguish two semantic alternatives:

a) culture generated by science
b) culture proper to science.

2. **Culture through science**
Two alternatives are also possible:

a) culture by means of science
b) culture in favor of science.

3. **Culture for science**
There are, similarly, two possibilities:

a) culture geared to the production of science
b) culture geared to the socialization of science.

In this last case, we would have in a) scientific dissemination and the training of researchers and of new scientists and in b) part of the educational process not contained in a), such as what

occurs, for example, in secondary education or in undergraduate courses and also in the museums (education for science), in addition to responsible, but wide publication, through the cultural dynamic of society's appropriation of science and technology.

These distinctions outlined here certainly do not exhaust the variety and the multiplicity of forms of interaction of the individual with topics of science and technology in contemporary societies, but may contribute to a clearer understanding of the semantic complexity entailed by the expression "scientific culture" and the phenomenon that it denotes in our age, itself characterized by other current denominations, in general forged on the fundamental role of knowledge in the political, economic and cultural life of these societies: the knowledge society.

The dynamic of so-called scientific culture may be better understood if we visualize it in the shape of a spiral. The idea is to represent it in two dimensions and to establish not merely the constitutive categories, but also the principal actors in each of the quadrants which its movement proceeds to trace graphically and to define conceptually.

Taking as point of departure the dynamic of production and the circulation of scientific knowledge among peers, that is, scientific dissemination, the spiral draws, in its evolution, a second quadrant, that of the teaching of science and the training of scientists; it subsequently proceeds to a third quadrant and so configures the set of actions and predicates of teaching for science and returns, in the fourth quadrant, thus completing the cycle, to its axis of departure, to identify there the activities particular to scientific dissemination.

Each of these quadrants, could, in addition, be characterized by a set of elements, which, parceled out among them, by the evolution of the spiral, also contribute to better understanding the dynamic of the process of scientific culture. Thus, in the first quadrant, we would have as destinators and destinees of science the scientists themselves; in the second, as destinators, scientists and teachers, and as destinees, the students; in the third, scientists, teachers, museum directors and cultural promoters of science would be the destinators, with students, and more broadly, the young public being the destinees; in the fourth quadrant, journalists and scientists would be the destinators and the destinees would consist of society in general and, in a more specific way, of society organized in its different institutions, including, and principally, those of civil society, which would make the citizen the principal destinee of this interlocution of scientific culture.

At the same time, we would have other actors distributed throughout the quadrants. Thus, by way of illustration, we would have in the first quadrant, with their respective roles, the universities, the research centers, the governmental bodies, the funding agencies, congresses, scientific periodicals; in the second, accumulating functions, the universities again, the system of primary and secondary education, the post-graduate system; in the third, the museums and science fairs; in the fourth, the magazines for scientific dissemination, the pages and editorials of the newspapers dedicated to the subject, television programs, etc.

It is important to observe, in this form of representation, that the *spiral of scientific culture*, upon completing the cycle of its evolution, when it returns to its axis of departure, does not return, nevertheless, to the same starting point. Instead it moves to a point enlarged with knowledge and participation of the population in the dynamic process of science and its relationship with society, opening up upon its arrival at the point of departure, there being no discontinuity in the process, a new cycle of enrichment and of active participation of the actors in each of the movements of its evolution.

Ultimately, what the *spiral of scientific culture* seeks to represent, in its intrinsic form is, in general terms, the constitutive dynamic of the inherent and necessary relationships between science and culture.[2]

The intersection of the two axes establishes four quadrants which in turn create fields of oppositions between categories and concepts, thus helping to explain and provide a better understanding of the dynamic traced by the spiral of scientific culture.

Thus, as we contemplate the position of each quadrant in the figure, it is possible, along the vertical, to highlight the opposition between the *production* and the *reproduction* of science, located in the lower half of the axis, and its *appropriation*, located in the upper half of the same axis.

This vertical axis thus establishes an opposition between what may be characterized as *esoteric*, that is, reserved to restricted circles, and that which is *exoteric*, or rather, of general interest, open to the public, without restrictions and in accessible form. The distinction between *esoteric* and *exoteric*, which dates back to the philosophical tradition of Greek Antiquity, makes it possible, for example, to distinguish between Aristotle's popular works, aimed at the public, in dialogue form, and to which he himself applied the second of the two adjectives in question, from his *acroamatica* writings which constituted the lessons he gave in the Lyceum.

Therefore, *esoteric production* and *reproduction* of science are opposed to their *exoteric appropriation*, by the nature of the audience – today we would say target public – at which the knowledge is aimed: closed, in the first case; open, in the second, making it possible to see, therefore, that these two categories are opposed, when considering the listening public, by quantity rather than by quality.

Along the horizontal axis, the opposition, in this case determined more by quality, would be between, on one side, that of *monosemic-educational discourse* and, on the other, of *polysemic discourse*, with a multiplicity of voices, polyphonic; while the former would be more directed, monophonic, orienting and oriented according to the didactic and pedagogical qualities that are particular to it, the latter would be characterized by the multiplicity of paths that lead to the truth (in the case of the production and the diffusion of science) and of the multiplied paths of the likelihood of its dissemination.

Figure 1 incorporates these sets of opposition of vertical and horizontal axes.

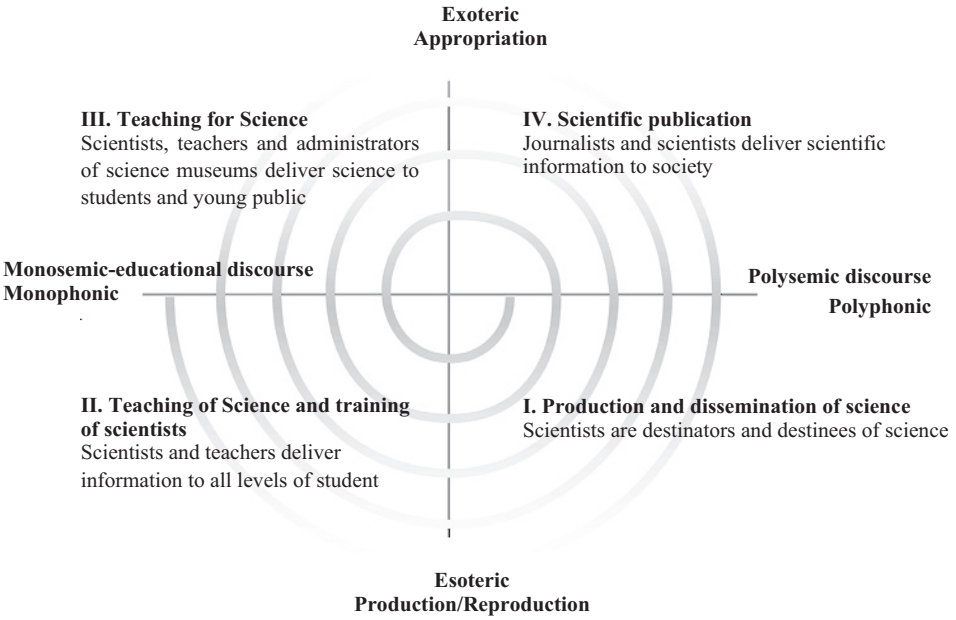

Figure 1. The axes of the spiral of scientific culture.

2. Cultural well-being

We all agree, or at least tend to agree, that science contributes, in one way or another, to the improvement in the quality of life on the planet. However, it is also true that the distrust of populations continues to accompany scientific development and the applications of knowledge in the generation of new technologies and innovations which are incorporated with ever-increasing frequency into our everyday lives. In addition to the aspects linked to social well-being which science could contribute in the form of the facilities it can offer through its technological and innovative applications, there is another kind of comfort which has to do with society's relationships with the technosciences, involving values and attitudes, habits and information, and presupposing an actively critical participation on the part of that society in the totality of these relationships. This type of comfort I would like to call *cultural well-being* and it is this that I also intend to touch on, albeit briefly, here.

The meaning of life is the knowledge that it is unlimited by the broadness of the question, and is, at the same time, limited and useful to the extent of our capacity to respond. Something similar may be found, or lost, in the metaphor of the universe: the library of Babel, which Jorge Luis Borges depicts for us in his famous story.[3] After perambulating through the paradoxes of the knowledge contained in its labyrinthine architecture, the author/narrator notes, in the form of a false conclusion, that the library is unlimited and cyclical. And he ends: "If an eternal traveller were to cross it in any direction, after centuries he would see the same volumes were repeated in the same disorder (which, thus repeated, would be an order: the Order). My solitude is gladdened by this elegant hope."

As we said above, what the *spiral of scientific culture* seeks to represent, in its intrinsic form, is, in general terms, the constitutive dynamic of the inherent and necessary relationships between science and culture.

To search for quality of life with the aid of science and its applications is, in this sense, to orient them towards compromise with world-wide social and cultural well-being. Cultural well-being is, thus, a conceit and a state of spirit which is characterized by the critical comfort of the disquiet generated by the systematic provocation of knowledge.

From this point of view, perhaps provokatively, one may distinguish two forms of ignorance that result from the two different ways of dealing with and relating to knowledge: *cultural ignorance* which is opposed to knowledge, as such, and *social ignorance* which is opposed to knowledge that is official knowledge, or authorized knowledge. In the latter case, ignorance is a state of lack of knowledge; in the former, that of cultural ignorance, it is a matter of a critical state of distrust in relation to the knowledge that one has or which one may come to have, which would enable us, paradoxically, to declare that the objective of knowledge is to place man in a constant state of cultural ignorance. Which would be tantamount to saying that cultural well-being is a paradoxical state of quality of life consisting, simultaneously, of knowledge and ignorance.

The dynamic of production and accumulation of knowledge in the contemporary world, in turn, could be analyzed starting from a broad variety of quantitative and qualitative data related to the scientific culture of a particular state, country or region. By way of illustration, one could set down a list, in the Ibero-American space of knowledge, as outlined by the movement, in chronological order, of the spiral of scientific culture, the Latin-American institutional facts and events in Figure 2.[4]

1940 – Venezuela: official building of the Venezuelan Museum of Sciences

1946 – Brazil: Museum of Life – Fiocruz (RJ)

1987 – Argentina: Rosario Experimental Museum of Sciences

1987 – Brazil: Science Station, University of São Paulo – USP (SP)

1998 – Argentina: "Eureka: science park"

1998 – Colombia: Museum of Science and Technology - Maloka, by The Colombian Association for the Advancement of Science (A.C.A.C.)

1934 – Brazil: University of São Paulo (USP)

1956 – Colombia: University of America (Bogotá)

1961 – Brazil: University of Brasilia (UnB)

1966 – Brazil: State University of Campinas (Unicamp)

1969 – Brazil: Paulo Souza State Center for Technological Education (CEETEPS)

1976 – Brazil: State University of São Paulo (Unesp)

1980 – Venezuela: Foundation of the Engineering Institute for Research and Development

1985 – Uruguay: the University of the Republic (created in 1849) recovers its autonomy

1949 – Brazil: *Ciência & Cultura* magazine (SBPC)

1960 – Argentina: magazine *Desenvolvimento Econômico*, of the Institute of Social and Economic Development (IDES)

1980 – Venezuela: magazine *Spaces: Venezuelan Magazine of Technological Management*

1982 – Brazil: *Science Today* Magazine (SBPC)

1988 – Argentina: *Ciencia Hoy* magazine

1990 – Uruguay: Uruguayan Academic Network (RAU)

1992 – Colombia: Innovation and Science Magazine (from ASAC)

1994 – Brazil: Laboratory of Advanced Studies in Journalism, Labjor, Unicamp

1995 – Chile: Chilean National Plan for Communication of Science through the Explora program, by CONICYT

1999 - Brazil: *Pesquisa* FAPESP magazine, FAPESP MediaScience Program and *ComCiência* electronic magazine (Labjor)

2003 - Brazil: FAPESP Agency – daily electronic bulletins

1948 – Brazil: Brazilian Society for the Progress of Science – SBPC

1951 – Brazil: Coordination for the Improvement of Higher Education Personnel – Capes

1951 – Brazil: CNPq – National Research Council (current National Council for Scientific and Technological Development)

1954 – Venezuela: Venezuelan Foundation for the Advancement of Science (FundaVAC)

1957 – Organization of Ibero-American States (OEI)

1958 – Argentina: National Council for Scientific and Technological Research (CONICET)

1962 – Brazil: São Paulo Research Foundation - FAPESP

1968 – Chile: National Commission for Scientific and Technological Research – CONICYT

1969 – Colombia: Colciencias – Colombian Institute for the Development of Science

1970 – Colombia: Colombian Association for the Advance of Science (ASAC)

1981 – Peru: National Foundation for the Development of S&T (FONDECYT)

1984 – Ibero-American Program of Science and Technology for Development (CYTED)

1985 – Brazil: Ministry of Science and Technology (MCT)

1991 – Bolivia: National Council for S&T (CONACYT)

1994 – Ibero-American and Inter-American Network of S&T Indicators (RICYT)

1997 – Paraguay: National Council for Science and Technology (CONACYT)

2002 – Argentina: Ministry of Education, Science and Technology.

Figure 2. Brazil and Latin-America.

In addition to events related to the creation of scientific institutions, funding and regulatory agencies, among other actors, as shown in each quadrant of Figure 2, the analysis of the temporal evolution of other, quantitative data, assists in the elaboration of indicators of scientific production. Brazil, and more specifically the State of São Paulo, serves as an illustrative example of this dynamic in which actors directly related with the S,T&I system interact.

Publications in scientific journals, which represent a standard of communication among scientists and fit into the first quadrant of the spiral, serve as indicators of scientific and cultural production of a country. Between 1981 and 2009, the number of Brazilian articles published annually in journals indexed by Thomson/ISI increased 16.5 times, growing from around 2000 to more than 32,000, respectively. In this same period, Brazilian scientific production, which represented 34.27 per cent of the publications in Latin America in 1981, grew to represent 54.42 per cent of this total in 2009. In this way, Brazilian articles increased from 0.43 per cent (1981) to 2.69 per cent (2009) of world scientific production (Figure 3). The scientific community of the State of São Paulo makes an outstanding contribution in terms of indexed papers of world class which corresponds to a little over 50 per cent of the national production in the course of all these years.

Moving on to the indicators that fit into the second quadrant of the spiral, dealing with the teaching of science and the training of researchers, the evolution is proportional. In Brazil, according to data from the Coordination for the Advanced Training of Higher Education Personnel (Capes), from the Ministry of Education (MEC), the number of PhDs qualifying every year, leapt from around 1000 in 1987, to more than 11,000 in 2009 (Capes/MEC, 1987–2009) (Figure 3), which represents an increase from 7.2 to 59.4 PhDs qualified annually, per million inhabitants during that period. In terms of higher education, this rate has increased from 683 to 2222 PhDs for each million Brazilians enrolled in undergraduate courses. The State of São Paulo, in turn, is responsible for the training of 45 per cent of the country's doctoral candidates over the period.

In financial terms, national expenditure on science and technology (S&T) increased from around R$15.3 billion (U$9.4 billion) in the year 2000, to R$50 billion (U$30.8 billion) in 2009, which represents, in terms of gross domestic product (GDP), an increase from 1.3 per cent to 1.57 per cent. The State of São Paulo, in turn, invested in S&T, in absolute value, around R$2 billion (U$1.2 billion) in 2000 and R$5 billion (U$3 billion) in 2009, which corresponds, respectively, to 4.72 per cent and 3.76 per cent of the State's total receipts for those years.

The demand for patents, an indicator of the evolution of innovation, is growing in Brazil at an accelerating rhythm – on average, more than 5 per cent each year, according to the latest data released by the National Institute for Industrial Property (INPI, 2010). The total number of patent deposits by residents in Brazil increased from around 5500 in 1996, to just under 8000 in 2009, which corresponds to an increase from 34 to 41 patent applications deposited per million inhabitants (patents/million inhabitants) in the respective years. Out of this total, more than 40 per cent of the applications were made by residents of the State of São Paulo (in 2007 there were 73 patent applications per million inhabitants in the State). In relation to patent applications for Brazilian inventions presented to the United States Patent and Trademark Office (USPTO), there was an increase from 0.9 to 2.42 applications per million Brazilian inhabitants over the same period.

The indicators outlined above constitute central elements in the dynamic of scientific culture which is developing in Brazil, more expressively, from the 1950s, and are related to the improved quality of life of the population, or rather, to the social well-being brought about by technological innovations. At the same time, however, that indicators of productivity in S&T are growing, in the form of scientific articles and patent requests, as well as the numbers related to the training of human resources and investments in the area, other cultural aspects related to society's

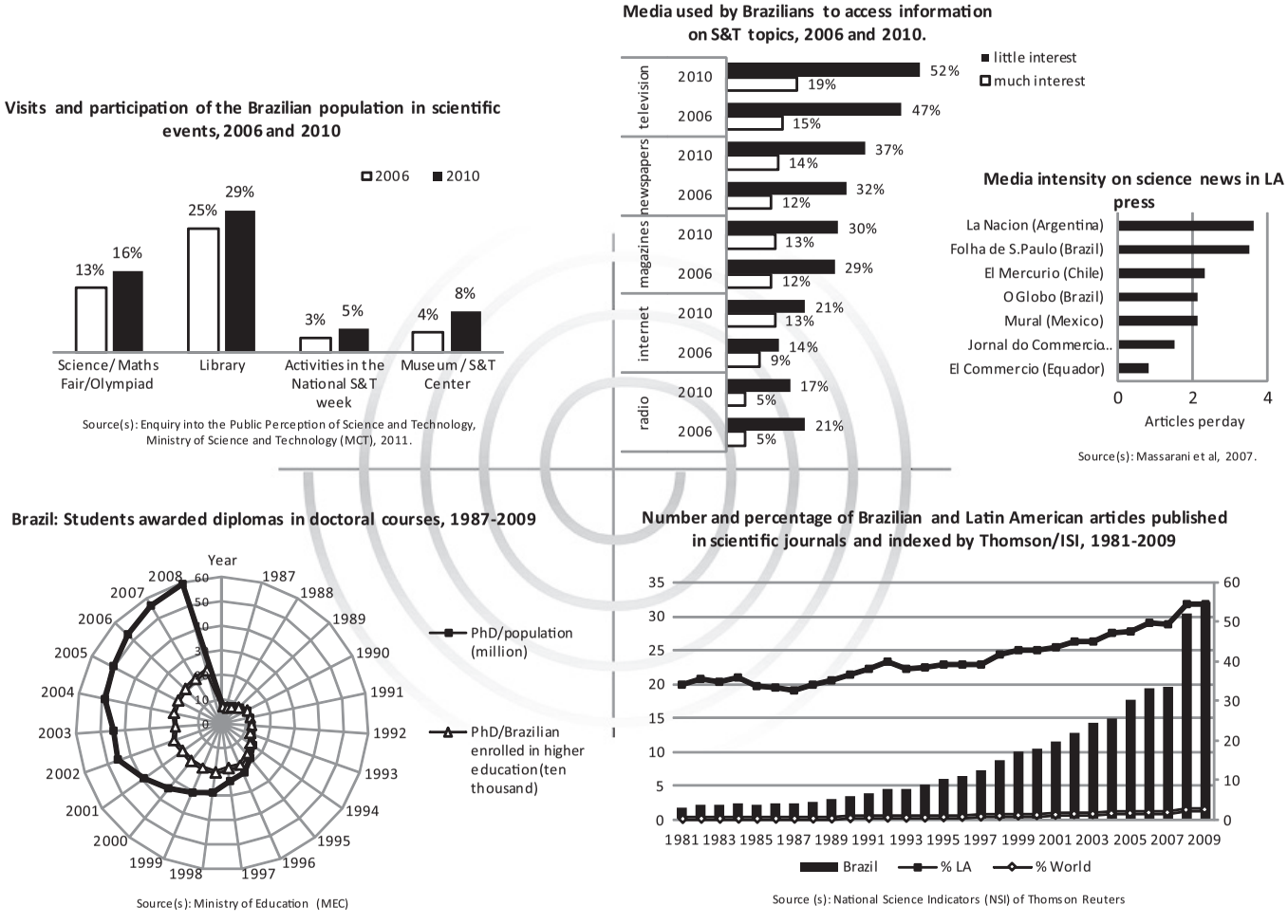

Figure 3. Scientific culture indicators.

perception and attitudes related to science are also evolving. These aspects, which are part of contemporary culture and are also measurable, fit into the third and fourth quadrants of the spiral of scientific culture, as we will see below.

3. Scientific culture indicators in LA

The values related to interest, information, attitudes, visions and knowledge that the society has concerning S,T&I constitute what we call *indicators of scientific culture* which depend, in this way, on the cultural well-being of the population. These indicators represent, today, an apparatus for taking public decisions in democratic societies, in the sense of both giving incentive to the communication of science, as well as developing systems for the participation of different actors in matters related to S&T. The research into the public perception or understanding of science and technology, on the basis of which these indicators are generated, is based on implicit or explicit models of scientific culture. These models, in turn, are related to different concepts of science, culture and scientific literacy.[5]

Research activities in the area have been evolving in the sense of incorporating quantitative indicators of S&T, deeper analyses and interpretations of the principal tendencies observed in the periods under examination, capable of assisting in the formulation and tracking of actions and policies for the sector.

In Ibero-America, research into the public perception of S&T is more recent, gaining a higher profile with the development of the Project for the Development of an Ibero-American Standard of Indicators of Social Perception, Scientific Culture and Participation of the Citizenry in S&T.[6] The initial idea appeared in 2001, and at that time an International Advisory Committee[7] and a Technical Team[8] were set up with the objective of constructing a regional agenda on the public perception of S&T and of formulating operational agreements that would make it possible to design a group of internationally common and comparable indicators.

Thus, the importance of developing indicators of the perception of S&T began to be recognized more forcefully in Ibero-America, only in recent years. Some countries in the region undertook national surveys into the public perception of science, starting principally in the decade of the 1990s, in a more or less systematic manner, such as Portugal (OCES, 2000) and Spain (FECYT, 2003, 2005), or more sporadically, such as Colombia (COLCIENCIAS, 1994), Panama (SENACYT, 2001), Mexico (CONACYT, 1999, 2003) and Argentina (SECYT, 2003a, b, 2007).

This line was also adopted by Brazil, which since the decade of the 1980s[9] has carried out four significant national enquiries in the area (CNPq/Gallup, 1987; CNPq/Ibope, 1992; MCT, 2007, 2011), without a defined periodicity or common methodology. But it is after the 1990s, with the country restored to a democratic context, that the public perception of science and technology began to gain more space.[10] In 2006, re-addressing the theme within the ambit of the Ministry of Science and Technology (MCT), the Department for the Popularization and Dissemination of S&T coordinated a new national enquiry into the public perception of S&T, in collaboration with the Brazilian Academy of Sciences and the Museum of Life/Fiocruz (MCT, 2007).[11] The research was repeated in 2010 (MCT, 2011), with small alterations to the questionnaire, while remaining generally consistent with the methodology, as compared with the previous edition.

According to research undertaken by the MCT, the interest of Brazilians in topics in the area increased in the period between the two editions. In 2006, 41 per cent of those interviewed said that they were very interested in S&T; a figure which rose to 65 per cent in 2010. According to these data, the participation of the Brazilian public in scientific events, which would fit into

the third quadrant of the spiral of scientific culture, also increased over the period between the two studies: a 26 per cent increase in the participation in science fairs and mathematics Olympiads; a 15 per cent increase in the use of libraries; a 60 per cent increase in participation in the activities of National S&T Week; and a 108 per cent increase in the numbers of people who say they frequent museums and S&T centers (Figure 3).

The profile of the search for information, which would fit into the fourth quadrant of the spiral, however, did not change: the principal communication medium through which the population gets information on subjects of S&T is, currently, television (19 per cent very frequently), followed by newspapers (14 per cent), magazines (13 per cent) and the internet (13 per cent), a profile which has remained similar to that found in the 2006 research (Figure 3).

Another very interesting study, carried out more recently within the ambit of the Ibero-American Project and awaiting publication, reveals valuable data regarding the perception of young people aged 15 to 17 from several Ibero-American cities on the subject of S&T and the scientific and technological professions. The data relating to the pattern of consumption of scientific information adopted by these adolescents were demonstrated to be very similar to the general information habits of Ibero-American adults presented in another previously undertaken research (FECYT, OEI, RICYT, 2009).

In the study carried out with young people (not published), the communication medium indicated by this public as the principal source of this type of information was television, which might be expected, given that the majority of homes nowadays have at least one television set and this is the principal source of information for the population in general. In contrast to what was observed among adults, however, a high proportion of young people seek scientific information on the internet. This tool, with which young people are increasingly familiar, could also be considered as a strategic way of targeting this layer of the population for the dissemination of scientific subjects.

Science fiction, whether in the form of books, films or comic books, was also identified as one of the most frequent information habits of the adolescents, in relation to S&T, which could be credited to the huge offer of products of this kind on the market and to the great appeal that these have for young people.

4. Interest, information and communication

In the contemporary world, in which the knowledge society advances in great strides and in which information piles up, overlaps and becomes outdated in a matter of minutes, consolidated knowledge, which guarantees the cultural well-being of the individual, also guarantees power to whoever possesses it. In this context, in which S&T appears ever more interwoven in the daily lives of the population, whether in the form of the facilities afforded by technological advances in the lives of some, or whether through the threat that these advances may represent for others, scientific knowledge becomes fundamental for the full exercise of citizenship.

The ideal objective of those who popularize science is that scientific knowledge, as a cultural phenomenon – a fundamental part, that is, of the contemporary world's real scientific culture – may be treated and experienced like football. This analogy applies to the enthusiastic relationship of the public to the event, and only to the point where the differences between the two areas begin and the characteristics of one do not apply to the other – in the sense that each area assumes different expertise and processes of institutionalization, among many other striking differences. In the case of football, although those who actually play the game are few in number, there are many, in fact, who know the rules, know how to play, are critical of its performances, are thrilled by it and are passionate about it.

We are not all scientists, just as there are not many individuals who play football professionally and competently. For this, in addition to talent, there need to be structural conditions of institutional support, such as resources, management plans, education and training programs, which it is the duty of public policy to establish and make work, in a regular and efficient manner. The fact of not playing football does not prevent us from loving it, from being amateurs of its practice, from practicing it always, even when, most of the time, "merely" with a supporter's fervent admiration. Let it be like that with knowledge and with scientific culture! Let us all be, if not professionals, amateurs of science, as critical supporters and popularizers and participants in its practice and in its results for the social well-being and the cultural well-being of the populations of the planet.

5. Final considerations

The institutionalization of the actors who make up the system of S&T, their performance, society's attitudes and perceptions with regard to S&T itself and the topics of the area, as well as all the elements of scientific culture, in a general way, develop and progress in parallel, in a burgeoning dynamic. By way of illustration, following the rationale and the logic of the other figures in this article, the indicators of production, training, perception and information in S&T could be laid out in the spiral of scientific culture, in Figure 3.

This article seeks to outline, illustrated through the metaphor of the spiral, the actors, institutions and their performances, in addition to society's attitudes, that is to say, some of the various elements that make up scientific culture, as a whole, in such a way as to demonstrate that the development of such indicators occurs in parallel, in a cyclical process and in constant expansion. The question that remains open, therefore, for future discussions, since its response probably varies depending on the different realities of the systems of S&T in the different countries and regions of the planet, resides in the order in which such events occur. Or rather, what types of actions, results or initiatives in the field of S&T provoke the development of the other elements of scientific culture? Beyond this question, one thing that is certain and that does not depend on the order of things, is that science is intrinsically related to daily life and is part of the culture of societies, and that scientific knowledge, accumulated in this dynamic of events, affects in different ways the lives of people and the way in which they relate to the world.

Notes

1 The metaphor of the spiral of scientific culture was originally presented in Vogt (2003).

2 Porto (2011) picks up the theme of the spiral of scientific culture in an article that creates a dialogue on the various concepts of culture, presented by different authors, and, more specifically, of scientific culture, proposing, among others things, a recovery and an adaptation of the *spiral*, in three dimensions, based on the concept and mode of operation as outlined above.

3 J. L. Borges (1970) "The Library of Babel" in *Labyrinths* (Harmondsworth: Penguin).

4 I would like to express my thanks for the work in gathering the Latin-American institutional facts and events cited here, to Sabine Righetti, a journalist and researcher who works and collaborates with me in Labjor/Unicamp.

5 For more details, see Polino et al. (2006), Albornoz et al. (2003) and Vogt (2003).

6 The Ibero-American Project comprises, in the general coordination, Mario Albornoz (Centro Redes/Ricyt, Argentina), Álvaro Marchesi Ullastres (OEI) and Eulalia Pérez Sedeño (FECYT, Spain) and, in the operational coordination, Cecilia Cabello Valdés (FECYT, Spain), José Antonio López Cerezo (OEI/University of Oviedo, Spain) and Carmelo Polino (Centro Redes/Ricyt, Argentina). To facilitate the reading, throughout the text, the expression "Ibero-American Project" is used as a synonym of "Project for the Development of an Ibero-American Standard of Indicators of Social Perception, Scientific Culture and Participation of the Citizenry."

7 The members of the Advisory Committee are: Carlos Vogt (author of this article), Rodrigo Arocena (University of the Republic, Uruguay), Arturo García Arroyo (CSIC, Spain), Javier Echeverría (UPV, Spain), Tatiana Lascaris Commeno (UNA, Costa Rica), Emilio Muñoz (CSIC-Ciemat, Spain), León Olivé (Unam, Mexico), Miguel Ángel Quintanilla (Usal, Spain), Jesús Sebastián (CSIC, Spain), Inguelore Scheunemann de Souza (Cyted), Juan Carlos Toscano (OEI), Hebe Vessuri (Ivic, Venezuela).

8 Brazilian members of the Technical Team are the researchers Yurij Castelfranchi (Labjor/Unicamp) and Luisa Massarani, of Museu da Vida (Oswaldo Cruz Foundation – Fiocruz-RJ). The other members are: Tania Arboleda (Pontificia Universidad Javeriana, Colombia), Tamara Arnold (Conicyt, Chile), Montaña Cámara Hurtado (Complutense University, Spain), María de los Ángeles Erazo (Central University, Ecuador), María Eugenia Fazio (Centro Redes, Argentina), Antonio Firminio da Costa (Cies, Portugal), José Luis Luján (University of the Balearic Islands, Spain), Carolina Moreno (University of Valencia, Spain).

9 The Brazilian government began to show interest in mapping public opinion on scientific-technological topics in a pioneering piece of research undertaken in 1987, by the Instituto Gallup, at the request of the National Council for Scientific and Technological Development (CNPq/Gallup, 1987), through the Museum of Astronomy and Related Sciences (Mast). The objective was to analyze the image of science and technology within the Brazilian urban population.

10 In 1992, a new piece of national research to identify "what Brazilians think of ecology" was carried out by the Ministry of Science and Technology (MCT) and by CNPq (CNPq/Ibope, 1992). The study, in the historical context of ECO-92, in which ecology assumed a prominent role in the discourses of opinion shapers, deals with perceptions and values related to the environment and also with attitudes of citizens with regard to actions of conservation and raising of awareness.

11 The investigation, carried out by the CDN Studies and Research, was designed in collaboration with researchers from FAPESP and from the Labjor (Unicamp), as well as with international specialists (from the Ricyt and the London School of Economics). The questionnaire applied in the national research has eight questions in common with the questionnaire applied in the State of São Paulo, in 2007, the data from which facilitate national comparisons.

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