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The Study and Research Group for Non-Formal Education and Science Communication – GEENF was set up in 2002 tied to the Faculty of Education of the University of São Paulo (USP)/ Teaching Science and Mathematics Area. The GEENF is dedicated to studies, research, production and evaluation of activities and materials in the non-formal educational and science communication. GEENF works in partnership with several national and international research institutes as museums, science centers, zoos, botanic gardens, aquarium and others non formal spaces.

This booklet is a compilation of the works produced by the members of GEENF in English, Spanish and French. It contains book chapters and papers published in periodics and congresses. There are also abstracts of all thesis and dissertations presented by members from GEENF, from 2006 to 2012, supervised or co-supervised by Martha Marandino, GEENF's coordinator. All these works are organized in cronological order, the first of each category was the last published or defended. The thesis and dissertations has their original idiom Portuguese. The entire thesis and dissertations can be found in GEENF's homepage, at www.geenf.fe.usp.br in "projetos e pesquisa"/ "doutorado" for thesis or in"projetos e pesquisa"/"mestrado" for dissertations.

Martha Marandino

Iara Grotz Moreira de Vasconcellos

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Thesis Abstracts

Education, Science and Health at the Museum: an enunciative-discursive analysis of the exhibition at the Museum of Microbiology, Instituto Butantan

Carla Gruzman

Abstract

The objective of this research is to understand and analyze the authorship constitution movements of professionals who play the role of designers in the production process of the expository discourse in science museums. We believe that the exhibition discourse concerns not only the knowledge of the subjects involved in the design and in the development of the exhibitions, but also refers to the production conditions that characterize the process as a whole, as well as to the meanings attributed during the materialization of this discourse. The methodological approach used the framework of qualitative research in education, and focused on the long-term exhibition at the Museum of Microbiology of the Instituto Butantan (SP). The theoretical approach is based on the assumptions of socio-historical approach to the study of language of Mikhail Bakhtin and his Circle, which shows dialogical characteristics in different textual media and results as a concrete event related to the conditions that circumscribe the lives of individuals and the positions assumed by them. For this analysis we used the contributions that help addressing the principle of authorship in the discursive production, such as dialogism, statement, social horizons, otherness, voices and the concept of gender. The research was based on two complementary and articulated steps that integrate the methodological procedures. On the first step we invested in the study of exhibitions in science museums as a sphere of activity in which the object of our research emerges, where discussions on the concepts of education and communication were used in this particular unit. The second stage sought to focus the enunciative-discursive dimension of discursive productions of professionals participating in the design and development of the long-term exhibition of the Museum of Microbiology. From this study, in which a brief historical background and the emerging context of the Museum of Microbiology at the Butantan Institute were established, the long-term exhibition at the Museum was described and aspects of its constitutional process, such as the counter words present in the design of the exhibition, the compositional structure with emphasis on the texts and objects and the presence of the other in the production of expository discourse were analyzed. The results show that there are specificities in the authorship constitution movements of this discursive event, which makes it unique in the way that it expresses the relationship between social conditions of production, knowledge, the senses attributed by designers and their interlocutors. A noticeable aspect relates to how the space and time dimension is incorporated into the exhibition discourse and determines the attributes and meanings expressed in the text and objects. Another aspect relates to the voices which characterize the discourses of different social spheres (scientific, educational, aesthetic, spatial, among others) and that afford a glimpse through marks that are expressed in the exhibition discourse. Based on the analysis performed it is believed that exhibitions in science museums could be considered a kind of discourse, hybrid in nature in terms of enunciative-discursive.

Keywords: Education in museums, non-formal education, science exhibition, exhibition speech; enunciative-discursive analysis, science museums.

GRUZMAN, C. **Educação, Ciência e Saúde no Museu: uma análise enunciativo-discursiva da exposição do Museu de Microbiologia do Instituto Butantan.** Tese (Doutorado em Educação). Faculdade de Educação. Universidade de São Paulo. São Paulo. 2012.

The objects in science museums: the role of pedagogical models in learning

Ana Maria Senac Figueroa

Abstract

This study aimed to characterize the educational role of the objects / models in science museums. Thus, we consider in this study, the objects in the museum that were built with the intention of promoting relations of teaching and learning. We seek to point out the educational role of objects in museum exhibitions, as well as to characterize the potential of the object in expressing certain products and processes in learning to be presented in a museum exhibit. In addition, we sought to identify aspects related to the concepts and processes that subjects are able to perceive when observing the object in an exhibition. The methodological approach was based on the framework of qualitative research and was selected the Museum of Natural Sciences at the Catholic University of Minas Gerais. The choice of model of the skeleton of a giant sloth was because it is the object that by its size and position expographic draws the most attention. Moreover, it has an important role in the development of Biology and Paleontology studies, as well as meeting a wide range of important features, which made it suitable for this research. Museum professionals responsible for the production of models and makers of the exhibition were selected for interview. The five young people invited to participate in this study were 17 years old and currently enrolled in 2nd year of high school of a private school located in the city of Belo Horizonte, Minas Gerais, Brasil. We believe that choosing young people with the same level of schooling and affinities, of similar social levels and setting up friendship, ease social interaction, making the visit more fluid and natural. We took as reference the concepts of "learning in museums", by some authors such as George Hein, Falk and Dierking, Hooper-Greenhill and Scott Paris. Even for theoretical research, we chose fields related to education and objects / models in museums, especially in science museums. To collect the survey data, we combine the use of multiple sources, in order to obtain the necessary information regarding both the pedagogical intentions of the object, i.e. the model of the skeleton of the giant sloth, exhibited in the museum chosen as the interaction of young people in relation to this same object. For data collection with young people the survey had three stages: before, during and after the museum visit. The steps were recorded on video and audio, including interviews. Based on these results, we articulated the data from the whole "our eyes" and "look of the museum" and analyzed this data from the two axes related to the dimensions of learning, the conceptual axis and the axis of procedure. We also analyze the interactions of each youth, with the object and the whole pedagogic exhibition, from learning these axes. We realize that the intentions of the pedagogical model were understood by mostly young visitors which evidence, from the elements that make up the axis of conceptual and procedural learning analyzed. The interactions with objects in museums promote the possibility of observation, description and express prior knowledge, to promote discussion, development and testing of hypotheses. They also promote imagination, prompting questions. However, with regard to the proper formation of scientific concepts, to think how to present the object, the texts and images in museums are fundamental.

Keywords: Museums education. Pedagogical objects. Learning in museums. Non formal education. Science museums.

FIGUEROA, A. M. S. **Os objetos nos museus de ciências: o papel dos modelos pedagógicos na aprendizagem**. Tese (Doutorado em Educação). Faculdade de Educação. Universidade de São Paulo. São Paulo. 2012.

The constitution of education in museums: the functioning of the museum pedagogical device by means of a comparative study among museums of fine arts, human sciences and science and technology

Luciana Conrado Martins

Abstract

This work presents the complexities involved in museum education. The hypothesis is that this type of education has certain characteristics differentiating it from other education modalities, and that remain in absence of the institutional museum typologies. The objective of this study is to understand the singular elements of this type of education. We applied the methodological background used by qualitative research in education; the analysis focused on practices established by the educational sectors of the museums. In order to collect the data, we have selected three museums that have consolidated educational practice and enabled the comparison: The Museu de Arqueologia e Etnologia da Universidade de São Paulo (São Paulo), a human sciences museum; the Museu de Astronomia e Ciências Afins do Ministério da Ciência e Tecnologia (Rio de Janeiro), a museum devoted to science and technology; and the Pinacoteca do Estado de São Paulo (São Paulo), a museum of fine arts. The theoretical referential selected is the one developed by Basil Bernstein, the pedagogical device, which offers a systemic view of the mechanisms of the functioning and constitution of educational processes that take place in the museums. Other national and international authors were also consulted. Results show that there are specificities involved in this type of education. The first aspect is the existence of a field interested in the creation of public policies for museums. Bernstein names it an official field of recontextualisation, where the State power acts and the museums take part by adhesion, a sphere, up to present, of small influence in the determination of educative practices in these institutions. There is also an external sphere of regulation constituted by funding agencies of educational action, public and private. A second aspect evidenced by this analysis is the autonomy of educators to establish their objectives and educational practices, a situation that owes its configuration to the concept of education proposed by the museums. As a result, the educators are responsible for the production of original texts about education in museums and for the determination of their own educational practices. This situation is sustained by the existence of an intellectual field of education in museums that has become notorious nationally and internationally in recent years in part due to the work of educators. We have selected three analytical categories in order to analyze the determining factors in the context of the educational practice in the museums: time, space and discourses. The relation among these elements is determined by a museum educational logic, which presents specific practices due to the content/collection of each institution. Results show that the educational practice employed by the museums studied has a considerable dialogic content, what Bernstein refers to as indirect teaching practice. This practice, time, space and specific discourse/object are constantly negotiated by making use of parameters that are established and by taking into consideration the characteristics of the public and the educational objectives of each museum.

Keywords: museum education; non formal education; sociology of education, cultural policy.

MARTINS, L. C. **A constituição da educação em museus: o funcionamento do dispositivo pedagógico museal por meio de um estudo comparativo entre museus de artes plásticas, ciências humanas e ciência e tecnologia.** Tese (Doutorado em Educação). Faculdade de Educação. Universidade de São Paulo. São Paulo. 2011.

Learning activity in science museums

Alessandra Bizerra

Abstract

The museums have in common the character of cultural heritage conservation and extroversion regardless of their kind and origin context. Although historically the social role of these institutions have been changing in power and reasons, a dimension becomes clear: the museums, the model known today, are educational spaces, organized with human knowledge historically constructed, shared and re-produced by active subjects. How do the museums lead this process, considering their audience as composed of individuals that give values and meanings to this heritage? Intending a discussion on understanding the social role of museums in terms of appropriation and re-production of culture, we used the historical-cultural approach, based on the ideas of Vygotsky, Leontiev and Davydov and we focused on the process of learning concepts and practices. With this choice, we aimed to understand how the learning activity is structured in science museums. We have assumed a priori that these institutions are places where the learning process is present but not necessarily the activity of learning. We distinguished, therefore, "learning" from "learning activity", considering that the latter should be investigated. An institution was chosen for analysis, the Biological Museum of Butantan Institute, and we tried to understand its long-term exhibition through a historical perspective. For this, we analyzed documents and institutional and personal collections related to science education and science communiation practices held by the Butantan Institute since its creation (1901). The macrocycles of expansive learning founded helped us to understand the current exhibition not only as a product of the anxieties and assumptions of the team of professionals involved, but as a result of activities developed in a whole century, which currently affect the interactions between audience and institution. On a higher level of scale, the analysis of cycles and microcycles of learning activity was developed by the point of view of visitors and monitors. For that, semi-structured interviews with museum explainers and visitor families were recorded on audio and video. The theoretical approaches used in this research, including the concept of "communities of practice", offered important tips for organizing the educational activities in science museums, especially related to the positioning of the museum object as mediator artifact. Elements such as the use of germ-cell models and inquiry situations, the selection of nuclear concepts and practices, the promoting of the ascending from abstract to concrete, the movement between actions and operations, the use of the proximal development zone, the social and semiotic mediation, were described as important for the professional praxis of museum educators. With the relationship between activity theory and learning in museums, it is expected that this research may contribute to the understanding of museums as "mediators" structures which facilitate the many possibilities of interaction between the individuals and culture.

Keywords: museum education; informal education, learning, activity theory, communities of practice, science museum

BIZERRA, A. **Atividade de aprendizagem em museus de ciências.** Tese (Doutorado em Educação). Faculdade de Educação, Universidade de São Paulo. São Paulo. 2009.

Possibilities and limits analyzes of Science Public Communication by Laboratory of Experimental Atmospheric Pollution from the University of São Paulo

Mônica Lupião Lobarinhas*

Abstract

INTRODUCTION: Many authors have stated that the popularization of the science to the nonacademic public allows a more effective performance in educational, cultural or health-related interventions that can occur. OBJECTIVE: Analyze the acting possibilities and limits of a scientific production laboratory with the importance of the Laboratory of Experimental Air Pollution (LPAE) from the University of São Paulo Faculty of Medical Sciences in Public Communication of the Science. METHODS: The qualitative research was the methodological reference adopted in this study. All papers published by LPAE, from January 2006 to June 2007 were analyzed; fourteen LPAE´s researchers were interviewed; nineteen journalists that contacted LPAE for accomplishment of interviews that involve this laboratory between January of 2006 and June of 2007 answered a questionnaire; and environmental education actions accomplished by LPAE were surveyed. RESULTS: The science public communication accomplished by LPAE happens through all of the nonacademic media communication vehicles in a constant way. The perception of the disclosure by the nonacademic press is very discordant among the researchers group. Certain dissatisfaction is manifested by some of the researchers, indicating that they would like a more expressive insertion. Some of them assume that all researches can be transmitted to the nonacademic public, while some of them declare that there are limits to the transmission of that information. The analysis of the relationship between journalists and scientists reveals important conflict points. The scientists criticize the journalists' unpreparedness to the interview. Journalists indicate that they perceive an unbalanced relationship, where the scientists put themselves in a prominence place. Among the journalists the notion of right of the media emerges, to be exercised in order to transpose the barriers between the academy and the other members of the society. They point out difficulties related to the comprehension of the language used and the understanding of scientific process, distrust of the academy in relation to the press, little opening of the scientists to other opinions and difficult access to the scientist. The LPAE actions in partnership with Basic Schools have reached total or partially their objectives with both the teachers and the students. This study proposes a subcategory of the public communication of science denominated education public participation model. Both teachers of elementary schools and scientists demonstrated interest in working together. However the actions only happened when intermediated by a professional linked to both LPAE and the school. CONCLUSION: Along its existence, the LPAE remains in the nonacademic media in a constant way. Several tension points emerged in declarations of both journalists and scientists allowing an evaluation of the main subjects that permeate the relationships among these professionals It is possible and of interest to the teachers and scientists the exchange in a continuous way between the scientific production centers and the basic school. However the public schools net structuring does not stimulate such practice, hindering the implantation or the continuity of initiatives of this load. To make them viable, it is necessary a responsible professional for the intermediation of the process.

Keywords: Health communication, Public perception of science, Environmental health, Qualitative research, Interprofissional relations, Public information

Lobarinhas M. L. **Análise de possibilidades e limites de comunicação pública da ciência realizada pelo Laboratório de Poluição Atmosférica Experimental da Faculdade de Medicina da Universidade de São Paulo.** Tese (Doutorado em Ciências). Faculdade de Medicina, Universidade de São Paulo; 2008.

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The Biological Knowledge in Exhbitions of Scientific Museums: an analyzes of the building up of the expositive discourse

Martha Marandino

Abstract

The objective of the present research is to understand the making up of the expositive discourse in exhibits of Science Museums which work with areas connected with Biology. The characteristics of the various discourses and areas of knowledge that participate in that making up were described as we identified what happens to scientific knowledge when is to be expressed in exhibits. The methodological approach was based on the principles of qualitative research. Five exhibits were selected from the following museums: Museum of Zoology, Museum of Veterinarian Anatomy, Oceanographic Museum, Science Station, all belonging to the University of São Paulo (SP), besides the Museum of Life – Biodiscovery Space of the Oswaldo Cruz Foundation (RJ). The theoretical fundaments that were used at first were those of the concept of didactic transposition suggested by Chevallard, or more specifically, that of museographic transposition indicated by Simmoneaux and Jacobi in the discussion of the transformation process of the scientific knowledge. Realizing the application limits of those concepts, new theoretical principles were utilized and the research focus was directed to studying the building up of the expositive discourse and its relationship with the scientific and the pedagogic discourse. Bernstein's concept of the pedagogic discourse was used as well as the principles of communication in museums from Davallon's work. Based on the articulated study both of the history of Biology and of the history of museums the exhibits were described and their constitutive elements were analyzed such as texts, objects, the relationship between collection, research and exhibit, the discourses that were present and the role of the biological discourse in the formation of the expositive discourse. Based on the data obtained, three items were discussed. The first refers to the educational and communicational perspectives of the exhibits analyzed. It was observed that, depending on the exhibit conception there were expositive strategies oriented either to information transmission or to reception. Nevertheless there are not only transmitting or receptive museums, but rather the use of resources that give first relevance to one or other interactional mode in dealing with the public. Besides, the exhibit organizers are not always aware of those options. A second aspect that was analyzed relates to the play occurring in the expositive discourse constitution: the expositive discourse has a similar behavior to Bernstein's pedagogic discourse, for it displaces other forms of discourse based on its own principles and objectives and assuming the characteristics of the "recontextualizing" discourse. Nevertheless it is worthwhile observing that the expositive discourse has specific characteristics different from the school pedagogic discourse which results from the relationships between time, space and the objects in the museums with direct implications upon the evaluative rules of the discourse constitution. It is postulated that the expositive discourse constitutes a specific discourse, since as it has its own objectives and as it arranges other discourses according to its own logic, it behaves similarly to the pedagogic discourse. At last present day questions on the issue of biology exhibitions in museums were discussed. After an analysis of the role of the biology discourse in the making up of the expositive discourse, challenges, limitations and possibilities, that the biology area must impose in order to be presented, were discussed. Various perspectives were suggested aiming at presenting Biology in museums.

Keywords: science museums, making public of biology, expositive discourse, scientific discourse, pedagogic discourse, bioexhibitions, didactic transposition, museographic transposition.

MARANDINO, M. **O Conhecimento Biológico nas Exposições de Museus científicos: uma análise da construção do discurso expositivo.** Tese (Doutorado em Educação). Faculdade de Educação. Universidade de São Paulo. São Paulo. 2001.

Dissertations Abstracts

The child in science museums: analysis of the exhibition World´s Children Museum of Science and Technology PUCRS

Cynthia Iszlaji

Abstract

The present study aimed to examine whether and how science museums take into consideration the young child in their actions in exhibitions. To this end, the research aimed to understand the concept of children and childhood from the changes over time. In this research, the conception of children and childhood is based on the discussions of Vygotsky, whose theory is oriented in a historical-cultural perspective. The child who emerges from studies of this theory is a child to be understood as a historical, social and cultural, since he influences and is influenced by determinants that constitute the social formation in which it is inserted. The choice of the context of the research was based on the results of the questionnaire sent to the Brazilian science museums in order to map the institutions to develop exhibits and / or educational interventions for children. For this study, we selected the exhibition World´s Children Museum of Science and Technology PUCRS, by presenting a designed area for children 3-6 years. Configured as a qualitative research, the data collected was through interviews investigating the designer of the exhibition, the supervisor monitoring and monitoring, as well as the observation of the exhibition and documental analysis. To perform the data analysis, categories were created from the assumptions of cultural-historical theory of Vygotsky, in order to characterize the conception of the child presented in the exhibition for young children. The categories developed were: organization of the physical and social forms of expression and the formation of children's concepts. Thus, the analysis was divided into three moments. At first we analyzed the museum exhibition in their space as a whole, in the second moment, we analyzed the apparatuses that provide forms of expression for children, such as play, drawing, imagination, and finally we analyzed the apparatus of the exhibition that stimulate the formation of concepts. However, it is important to note that there are few science museums that have exhibits designed for children, and most public activities answer this point in the long term displays. The exhibition features studied in their intentions and through their equipment and space, ways of promoting child development. Finally, we believe that this work brings important contributions to the determination of elements that can be considered by the teams responsible for the educational activities of museums, such as parameters for the process design for the exhibits for children.

Keywords: Non-formal education. Children. Science and Technology Museums. Childhood Conceptions.

ISZLAJI, C. **As crianças nos Museus de Ciências: análise da exposição Mundo da Criança do Museu de Ciências e Tecnologia da PUCRS** Dissertação (Mestrado em Ensino de Biologia). Interunidades, Área de concentração – Biologia. Universidade de São Paulo. São Paulo. 2012.

Museographic transposition of the biodiversity concept in the Ubatuba Aquarium: a study through the usage of concept maps

Maurício de Mattos Salgado

Abstract

The present work analyses the museographic transposition of the biodiversity concept in an exhibit of Aquario de Ubatuba, Ubatuba, SP. Biodiversity is a complex concept. Originally developed in ecology and the natural sciences, it was quickly integrated in a variety of fields and, often, with different and new meanings and interests. The importance of biodiversity for our society grows, and thus the need to better understand the educational processes that involve it. This research‟s objective is to understand the transformations that biodiversity goes through while being transposed from graduation textbooks to the marine ecosystems aquarium exhibit. The decision to use textbooks to represent reference knowledge is based on the notion that textbooks represent established theories and concepts of the academic community in question, the biology, ecology one. To allow comparison of knowledges in such different states as textbooks, exhibit texts and aquarium tanks, concept maps were used as an analysis tool. In order to study the academic knowledge, 3 graduation textbooks were used, selected by questioning major universities which were the most used ecology textbooks by their teachers. To study the aquarium, an interview with the Director and founder, as well as fully transcribing exhibit texts that belonged to the ecosystem exhibit. A method for describing the aquarium tanks, by using three depth levels, was developed and used in the tanks present in the marine ecosystems exhibit. The concept maps produced by these two units of analysis (books and exhibits) pointed to a much more species diversity focused biodiversity in the textbooks. This emphasis was not found in the exhibit that was preeminently focused around behavioral diversity. Man‟s role and relation with biodiversity while well present and explained in textbooks, connected with environmental threats but also with conservation, had little to show in the exhibit. Careful analysis of the maps allows differentiating the museographic characteristics of each exhibit object. While tanks were clearly adapted to communicating behavioral diversity, they were not good at showing genetic diversity, absent at the exhibit, but present in the academic knowledge as part of the definition of biodiversity. Determining knowledges present in the exhibit through the usage of concept maps is a useful tool in exhibit planning, as well as understanding the different roles that each object can play in communicating the concepts present in the exhibit. This research not only shows how each object in the studied exhibit is suited for teaching an aspect of biodiversity not really explained in depth by textbooks, the behavioral diversity, but also presents a method to produce concept maps of complex exhibit objects, contributing for future research.

Keywords: biodiversity, aquariums, didactic transposition, museographic transposition, museum education.

SALGADO, M. M. **A transposição museográfica da biodiversidade no aquário de Ubatuba: estudo através de mapas conceituais.** Dissertação (Mestrado em Ensino de Biologia). Interunidades, Área de concentração - Biolgia. Universidade de São Paulo. São Paulo. 2011.

The study of analogies as a teaching resource used by monitors in a science center of São Paulo/SP

Carla Wanessa do Amaral Caffagni

Abstract

In museums and science centers of scientific knowledge in this exhibition is a process of "transformation," which marks the transition from scientific discourse to the discourse to generalize, in order to make concepts in the exhibition more accessible to the visitor. Considering the educational function of museums and science centers, we believe that this process also happens through the different teaching strategies used by monitors carrying out the mediation between the public and exhibitions. In this study we chose to study one of these teaching strategies in the case, the use of analogies found in the discourse of the monitors during the presentation of scientific concepts in guided tours in the Science Center / SP. In studies of science teaching in formal education, the use of analogies has been observed as a teaching resource used heavily in explaining scientific concepts in the classroom. However, this is still an issue to be explored in non-formal settings such as museums and science centers. The method used here follows a qualitative approach, the analysis of predominantly descriptive data collected by the researcher in their study environment. Data were collected during the years 2008 and 2009 and the presentations selected for study were recorded in the exhibition "Life under water, The Mysteries of Water" and "Human Body", and have approximately 30 minutes each. Groups accompanied by the monitors during the guided tours were children of the fifth or sixth year of elementary public schools in São Paulo. Analysis of selected shift was made from a teaching model known as TWA (Teaching With Analogies), which served as the basis for developing a method of analysis based on component steps. The results show that the analogy is a resource used by the monitors and their production can be influenced by the teaching of museum space, related to space, object, activity time and language. Other aspects that seem to influence the production and use of analogies as a teaching resource, refer to the training of monitors and the objectives of the museum institution. It is thus better understand how analogies are produced in the context of museum education and pursue attempts to formulate better strategies for using this tool of language in situations of mediation so that they can be used effectively as a teaching tool in presenting scientific concepts present in the exhibitions.

Keywords: education in museum, mediation, analogies in teaching

CAFFAGNI, C.W.A. **O estudo das analogias utilizadas como recurso didático por monitores em um centro de ciência e tecnologia de São Paulo – SP.** Dissertação (Mestrado em Educação). Faculdade de Educação, Universidade de São Paulo, São Paulo, 2010.

Biodiversity and science museums: a study about museographic transposition on dioramas

Adriano Dias Oliveira

Abstract

This study aimed to examine how the concept of biodiversity is displayed in Brazilian science museums' exhibition dioramas, specifically regarding the way in which it is conceptualized and what type of values are assigned to it. To achieve this goal the research addressed the processes of transformation of the scientific discourse into an expository discourse, considering the theoretical concept of didactic transposition, understood here as museographic transposition. The focus on biodiversity is due to the proportions that the term has gained in recent decades, extrapolating the scientific limits and incorporating new meanings to it. This has required the development of differentiated instructional strategies in order for it to be used as a connecting tool by science education spaces. The reasons that led us to outline this work are the questionings on biodiversity and of how educational spaces approach them, especially on how museums use it with its dioramas. Two national museums were selected for this research, the Capão da Imbuia´s Natural History Museum and the Museum of Science and Technology of PUC/RS (Museu de História Natural Capão da Imbuia e Museu de Ciências e Tecnologia da PUC/RS), analyzing two dioramas of each. As a qualitative research the data collection was through the interview of scientists investigating biodiversity and of a representative of each studied museum, the observation of the dioramas and document analysis. Considering the theoretical framework on biodiversity and museographic transposition, there were created the following categories subdivided in two groups, which fundament the analysis: 1) Levels of biodiversity: genetic, species and ecosystems. 2) Biodiversity values: economic, ecological and conservational. Overall we found that the dioramas and its writings have similarities addressing biodiversity. The categories of levels of species and ecosystems predominate in these mounts, probably due to the historical relationship between dioramas and ecology. However, it is important to highlight that the texts centralize their information exclusively on animals, and that no plant species is mentioned. In one of the dioramas there could be identified elements regarding to the categories of biodiversity values. Based on the discourse of the museums´ representatives and on what was observed in the dioramas we found that the factors that cause some of our categories not to be found are related to museological and museographic issues. Such type of data reveals the existence of different fields of knowledge in the museological noosphere, which are present in the drafting of the dioramas. Finally, we understand that this work reinforces the efficiency of dioramas in portraying biodiversity to the science museums´ public and that it also contributes with a method of expository description of these objects for future research.

Key-words: biodiversity, dioramas, didactic transposition, museographic transposition, museum education.

OLIVEIRA, A. D. **Biodiversidade e educação em museus de ciências: um estudo sobre transposição museográfica nos dioramas.** Dissertação (Mestrado em Ensino de Biologia). Interunidades, Área de concentração - Biologia. Universidade de São Paulo. São Paulo. 2010.

Relations between science, technology, and society in science museums

Djana Contier

Abstract

The present dissertation analyzes how science museums in Brazil explore the relations and mutual interferences between science, technology, and society, using education focused on science, technology, and society (STS), and public communication of science as its main references. The election of STS-focused education is related to the discussion about the importance of training critical citizens to face science and technology (S&T) issues, including the science, technology, society, and environment (STSE) approach. The election of the public communication of science is related to the debate about the change in ways of public participation in S&T decisions. Those two references challenge the institutions that work on the public-science interface to reconsider their objectives and purposes. Those questions get even more relevant if the growth and strengthening of science museums in Brazil in recent years are taken into account. For this project three exhibitions from different national science museums were selected and analyzed: Educação Ambiental [Environmental education], at the Museu de Ciências e Tecnologia/ PUC-RS; Reprodução e genética [Reproduction and genetics], at the Biodiscovery Space at the Museu da Vida/Fiocruz; and Os Ciclos Biogeoquímicos e o Meio Ambiente [The biogeochemical cycles and the environment], at the Planet Earth and Environment Preservation at Estação Ciência/USP. In order to analyze these exhibitions, attributes that could qualify an exhibition as STS or STSE were composed. Those attributes were divided into three sets: the first applies to the attributes related to external social science issues; the second applies to the attributes related to internal social science issues; and the third applies to the attributes related to historical and philosophical debates. In this manner, the analysis was directed by identifying those attributes in the exhibit elements (objects, interactive displays, text panels, and other scenographic elements) in each of the exhibitions. The analysis leads to the idea of different ways to classify an exhibition as STS or STSE. A range from exhibitions that explore only one attribute in a particular manner to the ones in which all attributes are explored; between those two extremes there would be those exhibitions that bring only one attribute but in almost all exhibit elements; the ones which bring some attributes but only in one set; or, still further, those which explore many attributes but not all of them. Due to the difficulty of finding STS-themed exhibitions in the national scene, a discussion driven mainly by interviews with the exhibition elaborators, aimed at finding reasons and explanations for that low representativeness, was included in the analysis.

Keywords: Science museums. STS. STSE. Education and museums. Exhibitions analyses.

CONTIER, D. **Relações entre ciência, tecnologia e sociedade em Museus de Ciências.** Dissertação (Mestrado em Educação). Faculdade de Educação. Universidade de São Paulo, São Paulo. 2009.

The Educational Role of Botanical Gardens: analysis of the educational actions of the Rio de Janeiro Botanical Garden

Maria Paula Correia de Souza

Abstract

Botanical gardens are particular types of museums, especially because they exhibit living elements, most of them static. Among the functions of this type of institution, the educational one is particularly relevant within a growing valorization of informal education. In a qualitative research perspective, this study analyses the educational actions addressed to spontaneous and scholarship publics by the Rio de Janeiro Botanical Garden. We aimed to understand how these actions are being developed, creating knowledge for further thought about the educational role of these institutions. Within this perspective, we compared the historical development of botanical gardens with the one of museums, highlighting the growth of the education role in the Rio de Janeiro Botanical Garden. This analysis showed an increased importance of the education role in these institutions. For the Rio de Janeiro Botanical Garden, the initial relationships with the public were essentially based on the recreational function, but were then progressively changed, with the expansion of the educational function. In the recent history of the Botanical Garden we observed structural, political and social changes which resulted in the creation of public visiting sectors. To understand the social function of the institution, it is necessary to understand which are the fundamental concepts and aims of these public educational actions, and how were these actions evaluated and adapted. To support the proposed analyses, we created categories based on referential concepts from museum education, public communication of science, and also from pedagogical trends in science teaching. We observed that the educational actions developed for the large audience which visit the Rio de Janeiro Botanical Garden were usually developed within an information focused perspective. On the other hand, actions for scholarship publics presented more clearly dialogical elements. However, these categories do not obligatory exclude each other, once elements from more than one category may characterize each action. Apparently this mixture of dialogical and information focused characteristics may "coexist", without being better or worst for the public assimilation. This is similar to the present coexistence of different communication models, as well as of different educational elements and practices. Beyond the identification and characterization of different educational actions, this study allowed the institution to better understand their actions, and thus to adapt them to their maim objectives and intentions. In a wider perspective, this research contributed also for a critical thought about the social function of the Rio de Janeiro Botanical Garden, once it provides information about how the public perceive the educational and communication role of the Botanical Garden. Furthermore this study also showed that the relationships with visitors are becoming increasingly important for the institution, reinforcing the significant social role of the institution. Finally, our results emphasize the important role of this kind of evaluation and research about the educational actions developed in spaces such as botanical gardens, zoos, museums, and science centers, once they promote science communication, and allow an effective public participation in environmental and scientific issues.

Keywords: museums, botanic gardens, non formal education, museum education.

SOUZA, M. P. C. **O Papel Educativo dos Jardins Botânicos: Análise de Ações Educativas do Jardim Botânico do Rio de Janeiro**. Dissertação (Mestrado em Educação). Faculdade de Educação. Universidade de São Paulo. São Paulo. 2009.

Conceptions of popularization of science and technology in political discourse: impacts on science museums

Ana Maria Navas

Abstract

This research aims to characterize the concepts of science and technology popularization (S&T) that guided the discourse and the actions of the Science and Technology Ministry (STM) of Brazil, between the years 2003-2006. As part of the process, we examined the relations established among science museums and the processes of popularization and divulgation of science. We took as a standpoint one specific action developed by the STM towards science museums: the Public Call for proposals in financing Museums and Science Centers advertised in 2003. The theoretical framework used was based on studies developed in the area of sociology of science, public science communication, scientific divulgation and communication in museums. We used a qualitative approach with data collected in documents and through interviews. The sources consulted were official documents of the STM from 2003-2006 and the projects presented to the call for proposals. The interviews were performed with the members of the Thematic Committee of Scientific Divulgation of CNPq and professionals of science museums that would benefit from the Grant. The data showed that the popularization of Science and Technology currently receives support by the STM through the consolidation of the Department of Science and Technology for Diffusion and Popularization, including financial support and several other actions. Our analysis also showed that the discourse of popularization of S&T, characterized by tensions between informational and dialogical activities, is divided in the transmission of scientific contents and the incentive to the citizen participation in topics related to science and technology. Despite the predominance of informational activities of MCT, we identified in the governmental policy the intention to abandon deficient models, and to offer spaces for more participative and democratic models. Those intentions appear associated to the formulation of a public policy for popularization of C&T, and indicate an interest for assuming medium and long term commitments. In relation to the selected Public Call, it was evident the governmental intention of enhancing relationships between museum and popularization and science teaching. However, the analyzed projects showed that when this relationship is taken into practice, it privileges informational activities, turning back to the transmission of scientific content and associated to a school audience. Even so, the analysis of all projects presented by the museums to the Public Call showed activities designed for a more general population, and proposed in a participative and democratic context of scientific popularization. Those initiatives reveal the potentiality of the relationship that can be established between museums and science.

Keywords: popularization science and technology, politics of scientific divulgation, science museums.

NAVAS, A. M. **Concepções de popularização da ciência e da tecnologia no discurso político: impactos nos museus de ciências.** Dissertação (Mestrado em Educação). Faculdade de Educação. Universidade de São Paulo. São Paulo. 2008.

Learning in museums: an analysis of the school visits to the Biological Museum of the Butantan Institute

Agnes Sápiras

Abstract

Supposing that the exhibitions in museums reveal a great educational potential and considering the public evaluation as fundamentals to implement educational actions in these spaces, the main objective of this research was thought, which was the investigation of how the conversations established through the interactions between fundamental II students, during visits to the Biological Museum of the Butantan Institute, may enhance the learning process. We want to emphasize that the main goal was to analyse how the learning process was established from these interactions that comprised aspects of the information and meanings interchange established during the conversations among students, as well as with this students and the educators (monitors/teachers) and the interaction with the exhibition. In our theoretical framework we adopted authors who developed studies about learning in museums and since whe focused our analisys on the learning processes through interaction, we were inspired by the presuppositions of the social-historic perspective by Vygotsky. Our methodology had a predominantly qualitative character, but we did a brief quantitative research aiming to amplify the comprehension of the figures in the learning indicators. The datas were collected through observations and filming, being the analisys based upon a set of cathegories created by Allen (2002) for the study of learning in museums. According to these results, the category of conceptual talk was the most frequent, followed by the perceptual, strategic, affective and connecting talks. We believe that the view of the animals in the museum generated stimulus that unleashed a series of questionings among students who, through inferences and generalizations might have learned the scientific/biological concepts present in the exhibition – therefore being the conceptual talk more active. Moreover, the participation of the monitors during the conversations were important for the occurence of this cathegory. We believe that the cathegories developed by Allen (2002), helped in the comprehension of how the students appropriate the knowledge disclosed in the exhibition in the Biological Museum of the Butantan Institute, revealing new study possibilities related to the learning processes established in museums.

Keywords: learning, museums, interactions, students, non-formal education.

SAPIRAS, A. **Aprendizagem em Museus: uma análise das visitas escolares no Museu Biológico do Instituto Butantan**. Dissertação (Mestrado em Educação). Faculdade de Educação. Universidade de São Paulo. São Paulo. 2007.

An analysis of the conceptions about science, biodiversity and sustainable development within the discourse of a television program

Harlei Alberto Fiorentino

Abstract

The current work aims to analyze the conceptions of science, biodiversity and sustainable development present in the speech of one episode of the television program "Globo Reporter" entitled "Tumucumaque Park", which portrays a scientific expedition to this Park, located at the Brazilian State of Amapá. The approach used to analyze these conceptions is based on some guiding questions: what is the relationship between scientific and non-scientific knowledge? Which are the myths underlying the biodiversity approach? Which are the myths that support the idea of sustainable development? Is science presented so as to corroborate the conceptions of biodiversity and sustainable development suggested in the program? Do the conceptions underlying these issues resembles more the approaches adopted by developed countries and dominant groups, based generally on the neoliberal thinking and economic mainstream, or do they resemble more closely the ideas of dissident groups that are concerned with the cultural plurality and with the organization of social forums? The theoretical foundation of the work comes from philosophy and sociology, including authors who do not necessarily share the same views. Some examples are: Adorno, Bakhtin, Barthes, Habermas, Foucault, Ellias, Bauman, Giddens, Boaventura, Rorty, Berlin, Chalmers, Lyotard, Cassirer, Rouanet, Cambi, Castells. The method applied is of a qualitative nature, in which three features are basic: holistic vision, intuitive approach and naturalistic research. The theory is fundamental to provide support and validation to the study by attributing meaning to the data. The analysis showed that the discourse of the program is polyphonic, because it echoes contradictory voices, while reinforcing the voices of the dominant groups that disseminate the neoliberalism and the primacy of science over other forms of knowledge. Considering the educational aspect of the television, and the progressively decreasing monopolistic role of the school, it is important to value the capacity of "widening the gap" so needed for the perception of what is behind the appearances, of what is mythized and presented as undisputable truth. In the age of communication and of a society based on risk, in which the problems are global and the discourses are intertwined so to obscure clearly defined boundaries, schools must rethink their role.

Keywords: myth, science, biodiversity, sustainable development, discourse.

FLORENTINO, H. F. **Uma análise das concepções sobre ciência, biodiversidade e desenvolvimento sustentável presentes no discurso de um programa televisivo.** Dissertação (Mestrado em Educação). Faculdade de Educação. Universidade de São Paulo. São Paulo. 2007.

The museum/school relation: educational practice and theory on school visits to the Museum of Zoology of USP

Luciana Conrado Martins

Abstract

This research treats of the museum/school relation. Identifies and confronts the educational discourses and the practices of the involved professionals. Inserted on a qualitative view on education, this study analyses the present practices on school visits to the Museum of Zoology of University of São Paulo. It is considered that the museum's educators carry an empirical and theoretical knowledge, which is responsible for the normative conduction of the educational activities on the institution where they are involved. Other factors such as the institution's history, the administration's structure and the social context are relevant for the comprehension of the analysis field. Those are the aspects that are going to determine what is the discourse of the professionals of education who are responsible for educational actions of the museum, facing their pedagogical practises, necessary step to the comprehension of the object. On the other hand, it's as well considered that schools teachers have their own conception regarding the museum. What is this conception? What are the expectancies of those professionals, who confront innumerable difficulties to take their pupils to an institution whose language and contents are not familiar to them? Are their expectancies fulfilled during visitation? To understand the universe means to observe the practices of those professionals in contact with the museum institution. Aiming to answer those questions, the confrontation of the professional's expectancies (teachers and museum's educators) with their practices in a specific moment: the schools visitations to the Museum. This choice is based on the verification that the visit is the moment when the intentions, regarding to the pedagogical practice, are accomplished/confronted in a museum exposition. The choice for the University of São Paulo's Museum of Zoology, and posterior empirical research inside the museum, emerged other questions concerning the educational role inside the museological institution, historically dedicated to zoological researches. A referential originating in education researches and public researches, that took place in museums, was used to ground the proposed analysis. It was verified that teachers and museum's educators have similar expectancies regarding to the pedagogical potential of museums expositions. However, the schools still attending to museums without being alert to the educational particularities of these places, converting the visit on a isolated event to the school life of the student. On the other hand, the Museum of Zoology, aggregates factors, which contributes to the non-optimisation of its relation with school institutions. The evidencing of those problems indicates the need to enter an institutional partnership between museums and schools, supported by all the instances involved and not only few interested professionals.

Keywords: museum, school, partnership, teacher's knowledge, museum educator's knowledge, pedagogical practices, research in museum education.

MARTINS, Luciana Conrado. **A relação museu/escola: teoria e prática educacionais nas visitas escolares ao Museu de Zoologia da USP.** Dissertação (Mestrado em Educação). Faculdade de Educação. Universidade de São Paulo. São Paulo. 2006.

Les objets biologiques dans les musées de sciences : une étude dans le contexte brésilien

Martha Marandino

Introduction

Les expositions muséales deviennent de plus en plus l'objet d'études dans différents domaines de la connaissance. La compréhension du processus de production, en ce qui concerne le travail des équipes professionnelles, aussi bien qu'à ce qui se rapporte à la structuration et à l'élaboration du discours expositif, est fondamentale pour l'analyse de l'efficacité du rapport communicatif entre exposition et public.

Le discours des expositions est issu du processus de « muséalisation », dont le souci est la préservation des biens matériels par le moyen de la conservation, de la documentation et de la communication (Bruno, 1996). Dans l'exposition, le discours est, d'un côté, la source de communication entre des connaissances, des objets et des phénomènes et, de l'autre, le public. Dans son essence, le discours expositif est complexe et formé par divers éléments. De fait, dans l'analyse du processus communicatif, il est important de considérer autant les objets, les textes, les images et les maquettes que l'espace architectural lui-même et ses caractéristiques – comme l'éclairage, la circulation, etc. En effet, plusieurs auteurs ont récemment défini la visite d'une exposition comme une expérience holistique qui ne se réduit pas simplement aux contenus exposés (objets et connaissances), mais qui comprend aussi d'autres aspects concernant le bien-être et le confort des visiteurs. Ces aspects n'ont pas toujours été considérés dans les analyses de communications (Falk et Dierking 1992, Hooper-Greenhill 1994).

Étant donné la nature de la présente publication, ce texte se focalise exclusivement sur l'un des aspects qui déterminent le processus communicatif, à savoir les objets des expositions dans les musées

de sciences[1] dont le thème est la biologie. Les données qui seront ici présentées sont fondées sur une recherche de doctorat dont l'objectif principal a été d'étudier les processus de construction du discours expositif dans l'élaboration des expositions reliées à la biologie. Cette recherche doctorale a permis d'évaluer, d'un point de vue qualitatif, cinq musées de sciences brésiliens et, comme référence théorique, a eu recours au concept de recontextualisation de Bernstein (1996) basé sur la théorie du discours pédagogique.

Des cinq musées brésiliens retenus, deux ont été sélectionnés pour le présent article. Il s'agit du **Musée de Zoologie**, appartenant à l'Université de São Paulo – USP ainsi que du **Musée de la Vie**, situé à Rio de Janeiro et lié à la Casa de Oswaldo Cruz, de la Fondation Oswaldo Cruz (FIOCRUZ). Le choix de ces musées est dû à la représentativité des objets biologiques exposés, ce qui est fondamental pour les réflexions qui seront ici présentées.

Ce texte a pour but de réfléchir sur les questions qui surgissent lorsqu'on analyse les objets biologiques dans les musées de sciences. On aborde ainsi les thèmes concernant les divers types d'objets et la relation existant entre collection, recherche scientifique et expositions. On discute sur les possibilités et les limites reliées à ce genre d'objets exposés. On examine les différents aspects relatifs aux formes possibles d'interaction entre les objets des expositions étudiées et le public. Puis, enfin, on analyse les processus de recontextualisation subis par les objets biologiques pendant la production des discours « expositifs ».

Les objets dans les musées de sciences

L'existence des collections marque l'histoire et le concept des musées qui se sont construits à partir de l'accumulation d'objets. Au long des siècles, l'organisation et l'exposition des collections ont montré entre autres les différentes perspectives de la science de chaque époque.

Mais, avec le temps, et tout particulièrement durant le dernier siècle, des changements dans la perception et, conséquemment, la façon de concevoir les musées ont favorisé l'émergence de différentes conceptions des rapports entre les objets et les visiteurs et entre la recherche et l'exposition. Ces différentes conceptions remirent en question le concept de musée possédant une ou plusieurs collections au

1. Au Brésil, l'expression « musées de sciences » est habituellement employée pour désigner aussi bien les musées de sciences et technologies que les musées d'histoire naturelle et les centres de sciences.

point où apparurent de nouvelles institutions sans collection telles que les *sciences centers*. Ainsi, nous voyons apparaître des expositions qui ne se construisent plus autour des objets, mais plutôt autour de concepts et de phénomènes scientifiques, et ce, par le moyen de modèles et de systèmes de médias agencés.

Une des conséquences de ce déclin de l'objet est que la recherche scientifique, fondée sur les collections, a décru en termes quantitatifs et qualitatifs au point où elle est devenue parfois résiduelle ou même inexistante[2]. Par contre, un autre type de recherche, relié aux processus communicatifs et éducatifs, a émergé. Tout cela a eu un impact sur la conception, la production et l'évaluation des expositions dans les musées de sciences.

Il existe une importante bibliographie sur les objets de musées et les différentes approches faites en ce qui concerne la communication et l'éducation par le moyen de ces derniers[3]. Dans les lignes qui suivent, nous donnerons du relief à deux auteurs. Le premier, Lourenço (2000 : 73) qui a mis au point un système de classification d'objets pour les musées de sciences et technique. Dans ce système, nous trouvons trois grands types d'objets, à savoir les *objets scientifiques,* qui ont été construits dans le but de mener l'investigation scientifique, les *objets pédagogiques,* élaborés pour l'enseignement de la science, et les *objets de divulgation*, conçus pour la présentation des principes scientifiques à un public plus vaste. Les deux premiers types d'objets cités ont été incorporés aux collections parce qu'ils étaient devenus obsolètes. On les désigne sous le vocable d'« objets historiques ». Le troisième type d'objets a été conçu pour être délibérément manipulé dans un contexte d'exposition. Il est habituellement dénommé « objet interactif ». Il est à noter que l'auteure considère que les attributs « historique » et « interactif » ne sont pas intrinsèques aux objets. En effet, un objet historique peut, sous certaines conditions, être interactif. La valeur historique et l'interactivité sont ainsi des caractéristiques extérieures que tous les objets peuvent acquérir dans différents contextes[4].

2. Cela est le cas par exemple des musées universitaires d'Histoire naturelle dans la plupart des pays de l'Europe. (Lourenço, 2002).
3. À titre d'exemples, nous citerons quelques travaux concernant l'éducation et la communication par le moyen des objets : O'Neill (2000) ; Lourenço (2000) ; Schärer (1999) ; Kingery (1996) ; Shun (1994) et Silverstone (1992).
4. Selon Lourenço (2000), c'est le but de la construction de l'objet – un critère internaliste – qui garantit quelque objectivité et cohérence interne. En revanche, les critères comme interactif ou historique, de fond externaliste, ne permettent pas une approche objective du thème, puisqu'il s'agit d'attributs imputés lors de l'appropriation des objets, ce qui à son avis est impossible d'être contrôlé *a priori*.

Le second auteur, Schärer (1999), propose, tout en indiquant les intentions de la mise en place d'un objet sur scène selon la fonction qui lui est attribuée, sept approches fondées sur les possibilités de présentation des objets dans les expositions. Sous cette perspective, l'auteur définit des types de langage expographiques tels que le langage esthétique, didactique, théâtral et associatif. À son avis, les objets dans les expositions peuvent être *muets*, comme dans les cas des *musées-dépôts* ; *séducteurs* comme dans les *musées-rêves* ; *explicatifs/ exemplaires* comme dans les *musées-livres d'histoire* ; *désordonnés* comme dans les *musées-théâtres* ; *éducatifs* comme dans les *musées-écoles* ; *signifiants* comme dans les *musées-débats* ; *témoins* comme dans les *musées-rapport*.

Selon ces auteurs, il est possible d'affirmer qu'il existe différents critères habilités à classifier les types d'objets muséaux. Si le choix est fait par ses attributs internes, cette classification est en général plus objective et, conséquemment, indépendante du contexte dans lequel se trouve l'objet. Par contre, si une classification considère le contexte dans lequel se retrouve l'objet, cette dernière aura tendance à être moins objective. Néanmoins, cette dernière classification révèle les différentes formes sous lesquelles les objets peuvent être présentés ou interprétés par les visiteurs. Ce qui constitue, à notre avis, un élément important pour le processus communicatif dans les musées.

Comprendre les processus de fabrication des objets exposés dans les musées de sciences, les intentions transmises en filigranes, ainsi que les transformations subies par ces derniers en fonction du contexte pour lesquels ils ont été produits et sélectionnés, est essentiel pour la communication et la production de sens faites par le public.

Les questions qui seront ainsi présentées veulent contribuer aussi bien à la discussion sur la nature des objets présents dans les musées de sciences qu'aux implications dans la façon de les présenter et de les communiquer dans les expositions.

Méthodologie et univers de la recherche

La présente recherche a eu un caractère qualitatif et a été fondée sur l'approche ethnographique appliquée à l'éducation. Les données présentées dans ce travail ont été obtenues par le moyen d'*entrevues semi-structurées* réalisées avec les coordinateurs ou les concepteurs des

expositions[5], d'*observation des expositions* basée sur une grille élaborée à partir des critères d'analyse et de l'*examen des documents officiels*, des articles, ainsi que d'autres textes fournis par les institutions.

Le **Musée de Zoologie**, l'un des musées étudiés, a été créé en 1969[6]. Il appartient à l'Université de São Paulo, mais se trouve hors du campus universitaire, plus précisément, dans un quartier de classe moyenne. Sa collection remonte à l'année 1870 et a été constamment enrichie. Celle-ci, composée de divers exemplaires de groupes zoologiques, constitue la plus grande collection de l'Amérique latine concernant la faune de la région néotropicale. L'exposition étudiée dans ce musée a été élaborée dans les années 40[7].

Le **Musée de la Vie** a été créé en 1999 et est consacré à la divulgation et à l'éducation des sciences. Il est lié à la Fondation Oswaldo Cruz - FIOCRUZ, qui possède aussi un centre de recherche en santé et histoire de la science au Brésil. Situé à Rio de Janeiro, le Musée de la Vie est sur le campus de la FIOCRUZ, lui-même situé dans un quartier populaire de la ville. L'une des expositions étudiées dans cette recherche, appelée **Espace Biodécouverte**, aborde des thèmes qui se rapportent à la biologie moderne.

Les types d'objets dans les musées étudiés – Possibilités et défis

Dans la présente section, nous présenterons les données concernant les types d'objets existant dans les collections ainsi que dans les expositions des deux musées choisis. Nous présenterons aussi les recherches développées sur le terrain. L'exposition du **Musée de Zoologie** est consacrée à la présentation de la biodiversité animale et les objets qui la composent sont exposés selon les différents groupes taxonomiques. Il est à noter que la collection de ce musée a été constamment remaniée selon les conceptions de recherche liées au domaine de l'histoire naturelle et de la zoologie, en vigueur. Aussi, selon Rodrigues (1999 : 31), directeur du musée, les conservateurs n'avaient pas, à la fin du XIX^{e} siècle et dans la première moitié du XX^{e} siècle, le souci de collectionner des

5. Les témoignages qui sont ici présentés révèlent des noms fictifs, selon la décision méthodologique prise lors de la réalisation de la recherche. Dans le Musée de Zoologie, l'équipe de coordinateurs était formée par des biologistes chercheurs de l'institution. Dans le Musée de la Vie, les coordinateurs avaient des formations distinctes –biologistes, historiens, psychologues et éducateurs.
6. La collection du Musée de Zoologie est antérieure à la création du musée.
7. Le Musée de Zoologie a été fermé pendant quatre ans et sa nouvelle exposition de longue durée a été inaugurée en septembre 2002. La présente recherche a eu lieu en 1999.

séries d'exemplaires de chaque espèce pour l'étude de la variation géographique. Ainsi, les préleveurs, voyageurs ou naturalistes, ne collectaient qu'un ou quelques exemplaires de chaque espèce pendant leurs expéditions. De fait, ces derniers ne cherchaient qu'à augmenter leurs collections et exposer les éléments les plus spectaculaires au public. Cependant, les modifications qui ont eu lieu dans le domaine de la biologie ont influencé directement non seulement les thèmes, mais aussi les procédures et les méthodes employées pour la recherche dans ce musée. De fait, la diffusion des idées évolutives et des concepts de variation géographique parmi les zoologistes a rendu nécessaire la collecte de séries d'exemplaires co-spécifiques. Pour Rodrigues (*ibid.*), quoiqu'il n'existait pas encore des soucis visibles quant à la détérioration des habitats naturels, une partie de la collection témoigne de l'existence de communautés d'espèces dans des régions dont le paysage a été complètement modifié par le progrès des activités humaines.

Selon Rodrigues, les soucis actuels de préservation exigent des prises de position par des musées qui ont le rôle de documenter la faune des régions transformées. Outre les activités de recherche, le corps d'enseignants et de techniciens doit maintenir, conserver, amplifier et perfectionner les collections, tout en développant un travail de commissariat, et ce, afin d'utiliser les connaissances qu'on y trouve au bénéfice de la société.

Dans le **Musée de Zoologie**, les objets exposés sont ceux que l'on retrouve habituellement dans les musées d'histoire naturelle c'est-à-dire des animaux conservés dans des récipients ou empaillés. Ces objets, désignés ici comme des « objets scientifiques et/ou naturels[8] », sont représentés dans cette exposition par une grande variété de groupes taxonomiques. Cependant, la prépondérance de quelques groupes – comme celui des volailles – au détriment des autres est visible. Malgré la préoccupation des professionnels quant à la réduction du nombre des spécimens présents dans l'exposition, elle est encore importante et possède plusieurs exemplaires d'un même groupe répétés, selon l'indication du témoignage suivant :

> […] les espèces qui ont été préservées à l'occasion pour l'exposition, ils avaient une très bonne technique de taxidermie. On observe alors une grande préoccupation envers l'objet, mais le but était vraiment celui de le

8. Pour cette désignation, nous avons considéré les caractéristiques des objets scientifiques proposées par Lourenço (2000). Le terme « naturel » a été utilisé, car les objets représentés forment la base des études d'Histoire naturelle.

> montrer au public : « regardez, au Brésil nous avons tout cela ! ». Alors, plus on y exhibait, plus c'était mieux. Je pense qu'il s'agit donc d'une conception du siècle dernier : y mettre un nombre immense d'exemplaires (Sandra)

En ce qui concerne la présentation des animaux, quelques aspects doivent être mis en relief. Plusieurs exemplaires de l'exposition ont été montés à partir des techniques de naturalisation. Selon l'indication de l'un des coordinateurs, l'animal montré dans l'exposition publique est celui qui est « attrayant pour le visiteur ». Il est préparé, empaillé, « dans une position romantique, violente, agressive ou défensive, c'est-à-dire, il est immobilisé dans une position qui donne au visiteur l'idée de ce qu'il faisait lorsqu'il était vivant ». Au contraire, « l'exemplaire qui est préservé pour la recherche scientifique dans le but de laisser exposer la plupart des caractères qui sont importants pour son identification, c'est un exemplaire difforme » (Sandra).

FIGURE 1

Exemple d'animal naturalisé dans l'exposition du Musée de Zoologie

Ainsi, plusieurs animaux qui se trouvent dans l'exposition du **Musée de Zoologie** proviennent de différentes collections. Dans certains cas, ils ont reçu un traitement spécial afin de mettre en relief des aspects importants tels que l'apparence, les comportements ou la structure biologique, ce qui avait pour effet de les différencier énormément des animaux dédiés aux collections de recherche.

Les chercheurs de ce musée font des recherches dans le domaine de la zoologie, surtout en systématique et taxonomie, mais aussi en écologie et évolution. Ils sont responsables de la divulgation de ces connaissances

par le moyen de publications scientifiques. Les collections de recherche qu'ils possèdent forment la base de leur production scientifique.

FIGURE 2

Réserve technique de poissons dans le Musée de Zoologie – conditionnement des exemplaires pour la conservation et l'étude

Cependant, l'importance de la collection et, par conséquent, de la recherche scientifique réalisée dans cette institution, semble, selon l'opinion de l'un de ses coordinateurs, ne pas être mise en évidence dans l'exposition publique du **Musée de Zoologie**. Ainsi, selon Paulo « *les gens qui passent dans la rue et décident d'entrer ont une vision tout à fait erronée de ce qu'on fait ici* » (Paulo). Cette difficulté de montrer le travail de recherche réalisé dans le musée est le fruit, entre autres, de l'insuffisance de personnel – enseignants et professionnels spécialisés des domaines scientifiques –, mais aussi l'insuffisance de divulgation et de muséologie. Cela peut compromettre les collections et entraver la production de connaissance dans l'institution.

Il y a aussi des défis par rapport à l'amélioration des conditions et de l'infrastructure de l'exposition et du musée dans son ensemble. Cependant, tous ces facteurs sont, à vrai dire, des conséquences d'une politique institutionnelle qui pendant une certaine période n'a pas favorisé l'exposition publique comme une forme de divulgation. Selon l'indication du témoignage d'Ana : *« […] la recherche scientifique a toujours été priorisée au détriment de l'exposition publique. […] L'exposition occupait tout le fond de l'immeuble où se trouvent aujourd'hui les collections de mammifères et mollusques. Elle a été alors rassemblée dans un espace plus petit, c'est-à-dire qu'elle a perdu davantage son sens ».*

C'est ainsi qu'il devient possible d'identifier l'existence d'une profonde dissociation entre la recherche fondée sur les collections du **Musée de Zoologie** et son exposition à l'occasion de cette étude.

À travers les données présentées, il est possible de revaloriser l'importance de la collection zoologique et de la recherche développée dans le **Musée de Zoologie**. La recherche réalisée actuellement dans cet endroit démontre le rapport existant entre recherche biologique et collection et son importance pour le développement de la connaissance dans ce domaine. Les informations issues de ces recherches ne sont pourtant pas présentes dans l'exposition. En effet, cette dernière est strictement organisée sur la base de la systématique « classique »[9], c'est-à-dire exposant une grande quantité d'exemplaires et ne présentant que ponctuellement quelques connaissances écologiques à travers les dioramas. La dynamique de la recherche réalisée dans ce musée n'est pas représentée dans son exposition, ni d'ailleurs le rapport entre les connaissances les plus récentes de la systématique, de la zoologie et de l'écologie, ce qui est important pour la compréhension du travail réalisé dans le musée.

L'autre musée que nous avons choisi et étudié, c'est le **Musée de la Vie**. Sa proposition conceptuelle est vaste et a été élaborée dans le but de concevoir un musée interactif de sciences avec une mission éducative qui tient compte de la grande influence historique de la FIOCRUZ. L'exposition **Espace Biodécouverte** a pour objectif de divulguer des concepts élémentaires de la biologie à partir d'une perspective historique, ce qui maintient une relation étroite avec la recherche réalisée dans l'institution. L'exposition repose sur deux axes thématiques centraux, à savoir la *biodiversité* et la *santé* et traite divers contenus tels que l'évolution, la classification, la théorie cellulaire, la diversité humaine, la génétique, la reproduction et la biotechnologie, pour ne donner que ces exemples.

Dans le **Musée de la Vie – Espace Biodécouverte**, les recherches, en lien avec l'éducation, sont réalisées par les professionnels œuvrant

9. Dans ce texte, le terme « classique » se rapporte à l'École traditionnelle de la Systématique biologique. On peut distinguer deux tendances dans ce domaine de la connaissance biologique: la première, nommée École Fénétique qui comprend deux lignes – la Traditionnelle et la Numérique. Les deux lignes classifient les êtres vivants selon la ressemblance de leurs caractéristiques, la Traditionnelle étant la plus ancienne. La deuxième tendance comprendrait les écoles de systématique qui ont le souci de lier la classification et l'évolution ; nous y trouvons les écoles Cladistique et Gradistique (Amorim, 1997).

dans l'institution, c'est-à-dire les éducateurs, biologistes, historiens de la science, psychologues et sociologues. Par contre, il n'y a pas de recherche en biologie. Conséquemment, des consultations ont été faites auprès des chercheurs en biologie et en santé de la FIOCRUZ, afin de mettre sur pied l'exposition.

Le **Musée de la Vie – Espace Biodécouverte** ne possédait pas de collections. Celle qui est présentement exhibée appartient soit à d'autres secteurs de la FIOCRUZ ou a été tout simplement donnée par d'autres institutions.

Cette exposition renferme une grande variété d'objets, dans le sens proposé par Lourenço (2000), c'est-à-dire scientifique, pédagogique et divulgation. Ainsi, il y a, d'une part, quelques exemplaires d'objets scientifiques, d'instruments historiques, de végétaux d'animaux naturalisés, de fossiles puis, d'autre part, une grande quantité d'objets de divulgation et pédagogiques comme des modèles, des dispositifs interactifs, des jeux, des multimédias, etc. Notez qu'il y a aussi quelques organismes vivants dans l'exposition. Le témoignage ci-dessous illustre le rôle des objets dans cet endroit.

FIGURE 3

Exemplaires d'insectes exposés

Dans les entrevues faites aux coordinateurs de l'exposition, on a souvent eu comme commentaire le fait que la présentation des thèmes de biologie par le moyen d'objets occasionnait plusieurs difficultés :

> [...] Souvent, les musées interactifs travaillent avec des phénomènes reliés à la physique. Ceux-ci sont très faciles à illustrer ; c'est séduisant pour les gens. Quand il s'agit de biologie, vous traitez des spécificités difficiles à démontrer, qui exigent une grande quantité de formes très diverses ; et si vous voulez fournir des exemples à partir des expérimentations, je trouve encore plus compliqué [..] (João)

FIGURE 4

Module sur la théorie cellulaire – microscopes pour que le public observe les cellules avec l'aide des animateurs

À partir des données obtenues, nous croyons qu'il est possible d'affirmer qu'il y a plusieurs possibilités communes à n'importe quel processus d'élaboration d'expositions scientifiques, au niveau de la présentation d'objets dans les musées de sciences. Des défis se rapportant à l'approche interactive sont présents dans toutes les expositions d'ordre scientifique, puisque ce type de langage expositif, axé sur la participation active et tactile du public, imprime des caractéristiques spécifiques à l'élaboration du discours expositif. Les aspects se rapportant aux dimensions temporelles et spatiales sont aussi déterminants et agissent sur n'importe quel type d'exposition.

Cependant, certains aspects observés semblent posséder des configurations relatives aux spécificités des objets biologiques. On pourrait

ainsi considérer l'hypothèse que ces aspects maintiennent une relation entre les caractéristiques liées aux objets de connaissance de la biologie du point de vue de sa structure épistémologique, historique ou même philosophique.

L'histoire des Musées d'Histoire naturelle a influencé la conception des expositions dans ce domaine. La présence des objets scientifiques et naturels dans les différents types de musées de sciences rend évidente cette donnée, comme l'on a pu observer dans cette recherche.

Historiquement, la présentation des organismes conservés et organisés selon les groupes taxonomiques était liée à l'approche de la Systématique « classique », davantage centrée sur l'*information* à transmettre à travers les objets que sur le *public*. Cette présentation a été modifiée au fil du temps de façon que, dans certaines expositions orientées vers le public comme celle du **Musée de la Vie – Espace Biodécouverte,** les objets apparaissent dans le but d'éclairer le thème développé dans l'exposition. Dans le cas présent, le plus grand souci se trouve ainsi dans la compréhension du contenu à travers l'impact affectif et cognitif de ces objets sur les visiteurs.

La présence d'objets scientifiques et naturels marque l'héritage de l'Histoire naturelle et de son rôle en tant que science. À ce moment-là, présenter les sciences naturelles, son discours et sa logique était plus important que comprendre des concepts biologiques. D'ailleurs, l'organisation taxonomique des êtres vivants dans l'exposition et les propres objets de taxidermie étaient les fondements de cette approche.

Les expositions du genre interactif, marquées par une perspective éducative, sont associées en général à la présentation de connaissances supplémentaires et ne se réduisent pas aux contenus traditionnels de l'Histoire naturelle, comme la zoologie et la botanique. Les concepteurs d'expositions ont ainsi abandonné l'approche systématique classique au profit d'une organisation autour d'axes thématiques où les objets apparaissent afin d'illustrer les concepts ou les phénomènes traités.

L'Histoire naturelle a subi des modifications profondes dans ses fondements, notamment avec l'émergence de la Théorie de l'Évolution. La biologie, quant à elle, est en train de se constituer comme une discipline autonome et unifiée, quoiqu'il n'y ait pas de consensus dans le débat sur ce thème (Smocovits, 1992 ; Gros, Jacob et Royer, 1978). Cela a favorisé un apport de nouveaux contenus qui ont eu une répercussion sur la science contemporaine – qualifiée par certains de

techno-science (Jenkins, 1999), tout spécialement dans les domaines reliés à la Génétique, la Biologie moléculaire, ainsi que l'Écologie. La conséquence de cela est l'émergence de nouvelles questions à l'intention des musées qui développent des expositions en biologie et qui veulent divulguer correctement ses concepts, rendre possibles des lectures par le public et travailler avec l'historicité et la contemporanéité de la connaissance scientifique.

Selon Van-Präet :

> la dissociation introduite en sciences naturelles au xx^{e} siècle entre, d'une part, l'exposition et, d'autre part, les principes de constitution des collections et de la recherche scientifique, résulte de deux contradictions spécifiques au domaine biologique. La première est liée à l'objet d'étude lui-même, " à savoir l'impossibilité de faire tenir dans le temps d'une visite (quelques minutes) d'une exposition, un phénomène écologique ou évolutif (qui se déroule sur plusieurs mois à plusieurs siècles) ou moléculaire (microscopique et souvent ultrarapide) ". La seconde est liée aux nouvelles tendances de la recherche biologique, puisque "l'observation exhaustive d'un spécimen a fait place à l'analyse de séries d'objets (spécimens) biologiques et à l'étude des processus qui les régissent ; or ces processus ne se matérialisent pas dans des objets muséaux " (Van-Präet, 1989 : 31).

La question du temps dans la présentation de la biologie dans des expositions constitue un autre grand défi. Selon Van-Präet (*ibid.*), il est difficile d'exposer certains phénomènes pendant le temps d'une visite, à « l'exception de quelques expériences de physiologie sensorielle, on a largement eu recours dans les expositions biologiques de ces nouveaux centres de culture scientifique à des artefacts (maquettes, audiovisuels, etc.) ». Cependant, selon l'auteur, ce genre d'*artefacts* présentent par contre l'inconvénient majeur d'imposer au visiteur « les conceptions du muséologue, sans possibilité d'observation critique, ce qui peut paradoxalement permettre une exposition d'objets authentiques ».

Actuellement, par rapport à la présentation de la biologie dans les musées d'Histoire naturelle, Van-Präet soutient qu'une exposition scientifique uniquement constituée d'objets n'est plus concevable, mais, d'autre part, on ne peut pas accepter non plus une exposition uniquement constituée d'artefacts (audiovisuels, maquettes, etc.). Le défi et la responsabilité de ceux qui les conçoivent se trouvent plutôt dans la présentation des objets, « leur sélection en fonction de leur contenu potentiel, leur situation dans un propos muséologique qui va de l'objet vers d'autres supports d'information » (*ibid.*, p. 32).

La simple disposition des objets dans les expositions – scientifiques et naturels, de divulgation ou pédagogiques – ne peut pas être considérée comme une solution pour les défis sur l'efficacité communicative et/ou éducative. La signification des objets dans les bio-expositions doit être bien construite afin de favoriser la communication du discours expositif destiné au public. Lorsqu'on propose aux visiteurs certaines possibilités d'interprétation de concepts et phénomènes scientifiques, il faut, pour que l'apprentissage soit correct, avoir un certain contrôle sur les lectures que le public pourra faire de ce discours. Quoique le visiteur ait le pouvoir de sélectionner les formes et les contenus, une exposition qui se prétend éducative doit orienter, à l'aide de stratégies expositives, le processus d'interprétation du public sur le contenu de la science. En fait, le défi sera toujours celui d'articuler « l'apprentissage dirigé » avec les moments libres, consacrés à l'usage et à l'interprétation personnelle des objets. Quoiqu'il ne faille pas oublier la finalité de l'exposition, celle-ci pouvant avoir des objectifs qui ne concernent pas l'enseignement.

Interactions entre les objets biologiques et le public

Dans cette partie, on vérifie les aspects se rapportant aux types d'interaction pouvant exister entre les objets étudiés et le public. Dans le cas du **Musée de Zoologie**, il n'est pas possible d'affirmer que les objets exposés favorisent une quelconque interaction avec le public, puisqu'on n'y trouve pas d'objets ou d'artefacts qui peuvent être manipulés. De plus, il y a peu d'information textuelle disponible sur les étiquettes et les panneaux. Les animaux sont regroupés dans des vitrines et ils sont empaillés ou conditionnés dans des récipients contenant des liquides de conservation. Cette présentation favorise des comportements plutôt passifs de la part des visiteurs. L'observation détaillée peut toutefois susciter des questions et transmettre des informations qui ne sont pas toujours écrites. Selon le témoignage de l'une des coordinatrices de cette exposition :

> […] les enfants passent devant l'autruche plusieurs fois et ils n'observent pas les [objets ingérés par l'animal] qui se trouvent par terre et qui pourraient les renseigner sur elle. Ils ne les voient pas ; et pourquoi ? Ils les verraient plus facilement s'il y avait un dessin à côté, montrant les objets. Parce que cette habitude de regarder les objets et de les rechercher d'un regard dépourvu d'information n'existe plus (Sandra).

Ainsi, le public interagit, dans cette exposition, essentiellement à travers l'observation d'objets. Dans le cas du **Musée de la Vie – Espace Biodécouverte**, on considère que l'attitude du public présente des

similarités avec celui observé dans le **Musée de Zoologie**, c'est-à-dire, il met en relief des comportements d'observation et de contemplation. Par contre, les objets de divulgation, souvent présents dans l'**Espace Biodécouverte**, permettent la participation du public de façon diversifiée. Il y a dans cet espace des exemples d'artefacts du genre *hands-on* comme le jeu de mémoire sur la « biodiversité », et plusieurs ordinateurs capables de fournir des informations scientifiques et historiques sur les thèmes.

On peut ainsi affirmer que, dans le cas des objets de divulgation, ceux-ci établissent en général un type de relation avec le public bien particulier, et ce, par le moyen de la manipulation, de la réalisation de jeux, d'expérimentations, de la préparation de matériel et de l'observation au microscope. Les objets de divulgation présents, tels que le modèle de cellule, les modules interactifs, les jeux et les vidéos, ont été spécialement élaborés pour cette exposition afin de promouvoir la participation active, la manipulation et l'apprentissage des concepts.

Par rapport à la présentation des objets dans les expositions, nous pouvons dire que les objets scientifiques et naturels renforcent les attitudes contemplatives, c'est-à-dire une relation qui se réalise plutôt au niveau de l'observation qu'à celui de la manipulation. C'est le cas des objets qui se trouvent dans le Musée de Zoologie et de quelques-uns de l'Espace Biodécouverte.

Quant aux objets de divulgation, ils favorisent en général la participation et même une interactivité qui favorise une manipulation. Dans le **Musée de la Vie – Espace Biodécouverte**, ces situations explicites de manipulations ont été identifiées dans les activités d'observation. Quoique les exemples de la présence d'objets de divulgation soient significatifs, ils apparaissent surtout quand la proposition conceptuelle de l'exposition est conçue en vue du *public* et quand le thème central se rapporte aux contenus de la Biologie moderne.

La tendance à la manipulation est une caractéristique des *sciences centers*, où la participation et l'interactivité sont très valorisées. Dans ce contexte, Lourenço (2000) dénonce l'illusion d'attribuer de la valeur à l'objet par son statut de « participatif » ou « interactif » comme garant d'efficacité didactique[10]. Il y a déjà des œuvres contenant des analyses critiques sur le thème de l'interactivité dans des musées (Semper, 1990 ;

10. Selon Lourenço (2000), les synonymes attribués à l'expression « objets participatifs » indiquent souvent un niveau de manipulation plus réduit que les expressions concernant l'attribut « interactif » qui indique que l'objet offre au visiteur un plus grand nombre de possibilités d'action.

Csikzentmihalyi, 1987 ; Lucas, 1985). Falcão (1999a), par exemple, relève quelques aspects gênants du langage interactif, car à son avis, il y a une identification naturelle de celui-ci avec les Sciences physiques dans les *Science centers*, rendant difficile son application dans des domaines tels que la Chimie et la Biologie. Notre étude renforce en quelque sorte ces considérations puisque la présence d'objets scientifiques qui mettent en relief des attitudes contemplatives a été plus commune lors de l'approche des thématiques liées à l'Histoire naturelle, ayant très peu d'objets de divulgation dans ces cas. Il est donc possible d'affirmer que par rapport aux musées étudiés, certains thèmes de la Biologie – en général ceux qui sont liés à l'Histoire naturelle comme la Zoologie et la Botanique – sont majoritairement présentés à partir d'objets du genre scientifique et naturel. En revanche, une pratique ordinaire consiste à aborder des thématiques de la biologie moderne – théorie cellulaire et hérédité – au moyen d'objets pédagogiques et de divulgation.

Actuellement, on propose que les objets de musées de science et technologie soient conçus de manière à procurer des interactions du genre *hands on*, *minds on* et *hearts on* (Wagensberg, 2000). Dans cette étude, nous n'avons pas eu l'intention d'analyser le type spécifique d'interaction que chaque objet fournit dans sa relation avec le public. Cependant, on peut assurer que les objets scientifiques et/ou naturels, aussi bien que les objets de divulgation et pédagogiques, peuvent permettre ces trois types d'interaction. Nous mettons encore une fois en relief le plus important qui est la qualité de l'interaction entre l'objet et le public. Dans une exposition, la diversité de ces interactions – *hands on*, *minds on* et *hearts on* – est conseillée pour que l'on puisse procurer des expériences différenciées à des publics variés.

Nous considérons donc importante cette étude sur la nature des objets de musées de sciences et son impact sur le rapport avec le public, car nous pouvons ainsi corroborer ou non les positions qui garantissent que tous les objets peuvent à un certain niveau être interactifs ou contemplatifs[11].

11. Dans une recherche concernant des modèles d'interaction entre l'exposition et les visiteurs, Falcão (1999b) montre qu'il n'y a pas de lien de causalité entre l'efficacité pédagogique et le type de communication occasionnée par l'exposition, et ce, quelle soit contemplative ou interactive du type *hands on*. Cet auteur a constaté, à partir de l'observation du comportement d'étudiants dans une exposition didactique de sciences, que la contemplation peut procurer un engagement intellectuel productif. À son avis, cet engagement se produit à partir d'une expérience qui intègre simultanément trois dimensions, à savoir cognitive, affective et communicative.

Les résultats peuvent ainsi contribuer au développement de stratégies et de ressources expositives qui permet d'interpréter les thèmes, les concepts, les phénomènes et les objets dans les musées.

En considérant les deux expositions décrites dans ce travail, on peut affirmer que les objets étudiés peuvent être aussi bien scientifiques que pédagogiques ou de divulgation. On peut retrouver des objets de divulgation et/ou pédagogiques dans différents types d'expositions scientifiques, tels que des expositions sur la Physique ou la Chimie. Ainsi, les jeux, les interactifs, les hypertextes et les modèles sont des objets qui ont été conçus dans le but de divulguer des concepts scientifiques et peuvent donc faire l'objet de différentes thématiques scientifiques.

Pour étudier la production du discours expositif et comprendre le processus de construction et de sélection des objets de divulgation et pédagogique utilisé dans les expositions, nous avons considéré comme point de repère le travail de Bernstein (1996), et tout particulièrement en ce qui concerne ses concepts de discours pédagogique et de recontextualisation. Selon cet auteur, le discours pédagogique répond à un « principe d'appropriation du discours et de sa mise en relation, et ce, afin de permettre sa transmission et son acquisition» (*ibid*., p. 259). Ainsi, la dynamique de fonctionnement du discours pédagogique implique, selon les principes sélectifs de focalisation et de remise en ordre du discours pédagogique lui-même, une *dé-contextualisation* suivie d'une *re-contextualisation* du discours. Il s'agit donc d'un discours que l'on a *re-contextualisé*, à la suite d'une appropriation et à une réorganisation du discours en fonction de ses propres principes et intérêts.

Dans notre recherche, nous avons compris que les expositions peuvent aussi être vues comme étant des unités pédagogiques. Conséquemment, nous avons considéré le fait que le discours expositif peut être traité de manière semblable au discours pédagogique. Si, dans la construction du discours expositif, il y a des processus de recontextualisation, ce dernier ne peut pas être identifié comme étant un discours scientifique. L'exposition privilégie, selon sa proposition conceptuelle, certains objectifs et principes, ce qui constitue une condition au discours expositif.

Cependant, ce qui rend le processus expositif particulièrement intéressant et complexe, c'est qu'il y a aussi la recontextualisation de

l'objet muséal. Ce fait est déjà montré dans les œuvres de muséologie et, d'après Schärer (1999), quand ils font partie du processus de muséalisation « les objets sont décontextualisés de leur fonction primaire, chargés de nouvelles valeurs et intégrés dans des collections… afin d'être présentés au public ».

Dans nos deux musées, les objets scientifiques et naturels sont fréquents. De plus, le processus de préparation des objets naturels est ancien. Les animaux ont été naturalisés par des techniques qui cherchent à reproduire leurs comportements dans leurs habitats[12]. Ce processus de préparation, que l'on pourrait désigner ici comme étant un processus de naturalisation, a pour fonction de mettre en valeur les aspects importants de l'organisme pour des fins d'enseignement, de recherche ou d'exposition. Dans le dernier cas, l'objectif est précisément celui de le rendre plus attrayant pour le public.

Selon Van Präet et Poucet (1992), la présence de dioramas dans les musées marque un moment de rupture entre collection et exposition. Ce sont des exemples de stratégies didactiques qui apparaissent au XIX^e^ siècle dans les Musées d'Histoire naturelle, afin d'aider ces derniers dans leur mission éducative. Van Präet et Poucet mettent en relief la nécessité d'avoir recours à des activités qui favorisent l'accès aux objets.

FIGURE 5

Photo d'objet naturalisé dans l'exposition du Musée de Zoologie

12. Dans un texte trouvé sur un panneau de la Grande Galerie du Muséum national d'Histoire naturelle à Paris, on affirme que le processus de « naturalisation » représente l'art de préparer les organismes afin de les conserver et garantir leur durée. Elle est faite au moyen de diverses techniques adaptées aux caractéristiques de chaque espèce. D'autre part, la « taxidermie » est le processus de naturalisation de mammifères, oiseaux, reptiles et poissons. Elle permet d'attribuer à l'espèce l'apparence d'animal vivant. C'était une exigence des naturalistes du XVIII^e^ siècle. Au cours des siècles, on a développé de nouvelles techniques qui garantissent la présentation des espèces de façon plus attrayante.

Comme nous avons pu le constater, les objets naturels ont été retrouvés dans nos deux expositions, par contre, il faut savoir que leurs fonctions n'ont pas été les mêmes dans chaque exposition. Ainsi, dans le **Musée de Zoologie**, la structure mise de l'avant est basée sur le discours scientifique et fondée sur l'organisation de la systématique classique. Chaque objet renferme donc des informations biologiques et taxonomiques. Dans ce contexte, les objets ne sont pas nécessairement regroupés sous une thématique précise et favorisent ainsi de nombreuses interprétations de sens par le public. De fait, les objets naturalisés soutiennent le discours scientifique.

Dans le **Musée de la Vie – Espace Biodécouverte**, les objets scientifiques/naturels apparaissent par contre à titre d'exemple ou d'illustration de thèmes dans l'exposition, comme c'est le cas des *fossiles* utilisés pour expliquer l'*Évolution*. Lorsqu'ils sont mis dans un contexte déterminé et circonscrit par un thème, les objets acquièrent une autre fonction dans l'exposition, et ce, nonobstant les caractéristiques intrinsèques à ces derniers. Par contre, les différentes possibilités d'interprétation de l'objet deviennent subordonnées à l'objectif de l'exposition. D'une œuvre autonome, celle-ci devient le complément ou l'illustration du contenu exposé selon un axe thématique déterminé. Le discours expositif se centre donc sur la logique de la divulgation et de l'enseignement de la biologie.

Conséquemment à ces observations, nous pouvons déclarer que les objets scientifiques modifient leur fonction dans les différentes expositions selon les propositions conceptuelles qui les fondent. Dans le **Musée de Zoologie**, des *objets scientifiques* sont employés afin de soutenir un *discours expositif fondé sur la science*. D'un autre côté, dans le **Musée de la Vie – Espace Biodécouverte**, on utilise des *objets scientifiques* afin de soutenir un *discours de divulgation de la science*.

Les objets sont produits pour des contextes déterminés. Les êtres vivants naturalisés, existant dans les collections biologiques, sont élaborés selon des règles et des techniques qui les rendent propices à l'étude de la systématique, de l'écologie et du comportement. Par contre, les êtres vivants naturalisés, présents dans les expositions, ont été sélectionnés à partir de leurs attributs esthétiques, mais aussi didactiques, cherchant à la fois à divulguer la science et à provoquer une émotion sur le visiteur.

Néanmoins, les objets de collection, aussi bien que ceux qui sont faits spécialement pour une exposition, peuvent être utilisés dans des expositions. En effet, le rôle des objets dans ces lieux dépendra de la

proposition conceptuelle. Chaque changement de contexte auquel les objets sont soumis engendre différents modèles de recontextualisation. Un objet de collection change de contexte[13] lorsqu'il est présenté dans une exposition. Il est donc recontextualisé, mais il peut encore soutenir le discours scientifique et, par conséquent, son rôle dans son nouveau contexte devient celui de maintenir le discours expositif ayant comme base la structure logique et épistémologique de la science. Il ne sera pas, par contre, utilisé ni n'aura la même fonction ou valeur qu'il avait lorsqu'il était dans la collection de recherche. Même dans le cas des objets spécialement produits pour une exposition ou choisis pour y figurer, ceux-ci peuvent encore se maintenir dans la logique de la science, tout en renforçant ce genre de discours expositif[14].

Lorsque la proposition conceptuelle de l'exposition se fonde sur la divulgation scientifique, nous avons par conséquent de nouveaux modèles de recontextualisation. Dans ce cas, l'objet scientifique/naturel est re-contextualisé afin de soutenir le discours de la divulgation. La présentation de l'objet cherche à fournir des éléments pour la compréhension des concepts biologiques choisis dans le but de divulguer ou même d'enseigner les sciences. Sa fonction, son rôle et sa valeur intrinsèque ne s'appuient plus exclusivement sur le discours scientifique, mais illustrent, démontrent ou expliquent les thèmes présentés par d'autres moyens dans les expositions comme les textes, les hypertextes ou les artefacts interactifs. En ce cas, dans la production de l'exposition, le discours scientifique est recontextualisé et le nouveau discours produit – le discours expositif – se centre sur la logique de la divulgation et de l'enseignement de la biologie.

13. L'idée de « changer de contexte » ne concerne pas le sens usuel du terme, mais l'idée de changer les rapports que l'objet établit avec les autres éléments de ses alentours – sa trame conceptuelle, ses rapports historiques, épistémologiques, etc. – une fois que ce sont des éléments distincts. Donc, la recontextualisation implique l'enlèvement d'un discours (ou objet) de son contexte primaire et la remise de celui-ci dans un nouveau contexte fondé sur une autre logique et sur d'autres objectifs et principes.
14. Il est important de rappeler qu'il y a des expositions qui possèdent comme public-cible les spécialistes ; dans ces cas, il est difficile de les distinguer des collections de recherche. Ainsi, il est possible d'affirmer qu'il y a d'autres modèles de recontextualisation au-delà de ceux qui ont été ici mis en relief et qu'ils dépendent des objectifs et des propositions conceptuelles des expositions.

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Museographic Transposition: discussing scholarly knowledge of Biodiversity in the organization of museum exhibitions

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The aim of this article is to address present issues concerning the characteristics of scholarly knowledge on the concept of biodiversity in the organization of science museum exhibitions. It is part of a major (master's) study that analyses the changes this concept undergoes in the transformation from the scientific field to the museum; more specifically to diorama type exhibitions. In this paper, we show that themes, such as that of biodiversity, challenges the unambiguity of scholarly knowledge by unveiling its heterogeneity; a heterogeneity that in turn is influenced by both scientific and social aspects. To demonstrate how we establish the relationship between biodiversity, science museums and dioramas we will briefly present the polysemy of the concept of biodiversity and how from a historic point-of-view, life diversity has been exhibited in museums especially with the use of dioramas, which are considered display pieces with an educational role. We will also address aspects relating to processes of museum transposition, i.e., museographic transposition and an analysis of dioramas as a praxeology.

Este artículo tiene como objetivo abordar los cuestionamientos presentes en la caracterización del saber sábio, revelando su heterogeneidad sobre el concepto de biodiversidad en la elaboración de exposiciones de museos de ciencias. Para compreender como se estabelece la relación biodiversidad – museos de ciencias – dioramas, presentamos brevemente los aspectos pertienentes a la polisemía del concepto de biodiversidad y de como, desde el punto de vista histórico, la diversidad de la vida viene siendo expuesta en museos, en especial por dioramas, considerados aparatos expositivos con un papel educativo significativo. Abordaremos, también, aspectos relacionados a los procesos de transposición en museos, la transposición museográfica y un análisis de los dioramas como praxeología

Method

We studied dioramas in two museums: the Natural History Museum of Capão da Imbuia/PR and the Museum of Sciences and Technology of PUC/RS. We carried out a qualitative survey in which data were collected from semi-structured interviews with scientists who study biodiversity and from the analysis of extracts from books and manuals that treat the theme of biodiversity. Here, the aim was to map the scholarly knowledge on biodiversity. We also interviewed exhibition staff at each museum we studied to collect information on the production process of dioramas. Finally, we studied the dioramas in the two museums and analysed the official documents of the institutions. The categories for analysis were constructed from the collected data on the basis of theoretical considerations of biodiversity and the theory of museographic transposition.

The main focus of this article is the status of the scholarly knowledge. Therefore, from the data collected in our investigative universe we will focus only on the interviews conducted with scientists that study biodiversity and books and manuals that define the concept[1]. The texts chosen are widely used in academia – they are scientific and also for dissemination. Our research of these materials shows that when authors define biodiversity they often characterise its structure in *organizational levels*, and discuss which *values* may be assigned to the concept when addressing it. These aspects were used as a guide for us to prepare the categories of analysis which are divided into two major axes: biodiversity organizational levels – genetic, species and ecosystem diversity, and biodiversity values – economic, ecological and conservationist values. Three researchers from the Institute of Biosciences of the University of São Paulo (USP), who were chosen from different departments: genetics, ecology and botany, were interviewed. The choice of subjects from different areas of biology was intended to enrich the investigation of how biodiversity is studied and interpreted in the scientific and academic spheres.

Based on the data we produced on how biodiversity is presented and discussed in the scientific and academic fields, we noted peculiarities of what refers to the conception of scholarly knowledge found in the theory of didactic transposition.

Biodiversity and Natural History Museums

Due to the long-time and wide use of the term biodiversity, it has become imprecise as a concept within the scientific community, in particular in biology. Since its origin, the definition of biodiversity has been a focus of discussion in scientific scope and the term

[1]GASTON, K. J. 1996; LÉVÊQUE, 1999; PRIMACK, R. B. & RODRIGUES. E. 2001; RAVEN, P. 1992; WILSON, E. O. 1997.

amplified its impact as a resulting from the *Rio – 92* meeting held in Brazil. In that meeting, the "Convention on Biological Diversity" or CBD was ratified and recognized as the first world agreement aimed at sustainable use of all biodiversity components. In Oliveira's opinion (2005, p.43), the meeting "represented a dividing of the waters and enabled a widening the meaning of the term which went on to be used in other social, political, and economic contexts".

Although there is agreement on the meaning of the term biodiversity, we still do not have a consensus on its use among biologists (Motokane, 2005). Corroborating this idea, Gaston (1996) goes a little bit further, pointing out the unlikelihood of assigning the term a common denominator. Weelie & Walls (2002) are categorical when they say that biodiversity is an ill-defined concept, unable to offer a simple or universally applicable definition of the term. They go on to say that it is not difficult to find scientific, political or symbolic meanings all being used by the same person. Oliveira (2005), in turn, attributes this condition to the wider function the concept has, as there is not consensus in the different contexts in which it is used. In his analysis of the conceptions of biodiversity by teachers from different levels (elementary, secondary, and higher education) it was seen that a teacher's construction of a biodiversity concept is strongly related to the context and the teacher's own references.

The non-conformity in the field of biology mentioned in the works above, together with the popularization of the term seen after the CBD demonstrates how wide the concept of biodiversity is, and that it is not exclusive to biology and even less so to science. Although it originated from the concern with environmental changes that arose in the field of biology, we cannot deny the magnitude of the concept in society. However, in determining how precise it is as a concept we can only agree with Gaston (1996), who states that terminology mainly serves as a convenient human construction.

This adoption of concepts by actors outside the scientific context is a recurring event; however working with concepts outside this scope seems to be more and more challenging and at the same time necessary at different educational levels. At present, some concepts such as that of stem cells are being discussed beyond the academic environment such as in schools, in the media and at exhibitions. The term biodiversity was inflated and presently goes beyond scientific limits with new meanings being incorporated which in turn have demanded new educational strategies from the places that intend to use it as a tool of articulation in education for science.

In light of the specific characteristics that the concept of biodiversity assumes in the different contexts where it circulates, we must understand how the changes it undergoes are processed because it is a widely used term both in academia and in communication and education. In order to map how the concept changes, the aim of this study is to analyse how science and non-formal scientific and educational spaces work with the theme of biodiversity.

Museums, in particular those of natural history, from the beginning established a relationship with the diversity of life on the planet. In addition, from the beginning, museums have enabled contact between the public and the wealth of their collections and exhibitions. This legacy originated in private collections of noble Europeans in the 16th century. Having no scientific purpose at that time, these collections represented social status for those who owned them. Another value given to them was to be able to appreciate all the richness that God had put on earth to the benefit of mankind. These collections, formed by samples of plants, animals and historic objects, later formed the basis of the famous Cabinets of Curiosities whose goal was to exhibit all "things in the world". The 17th century was marked by great expeditions and with there was a significant increase in the collections of animals and plants leading to the construction of buildings intended to house them (Bragança Gil, 1988; Merhoff, 1997). The development of Natural History as a science in the 18th and 19th century led to the construction of various museums around the world with a view to safeguarding life diversity by means of their collections. Up to this moment the collection was also an exhibition – there was no distinction between them.

Natural history museums were virtually the first places to register and document life diversity. Mehrhoff (1997) points out that these places constitute important documents of the diversity that has existed on the planet, as large parts of what we currently know originate here. Further, museums continue to provide new information because they continue to receive new specimens and have species classified in their collections. Mehrhoff further states that the real value of collections lies in the fact that they represent irreplaceable knowledge on life diversity, a document of biodiversity in time and space, and to preserve them will help us to understand the richness of life on earth.

In Mehrhoff's opinion (1997), rather than seeking to promote such understanding, museums should seek with their exhibitions to arouse people's interest in biodiversity. In our opinion, this is the major challenge that is faced today not only by natural history museums but by any museum that proposes to exhibit biodiversity. Museums are structured and organized to combine their needs as research institutions with establishing a space of relationship with the public via exhibitions. This clear intention of the best possible public education brought to museums new professionals and consequently new and different interests in developing exhibitions with themes as comprehensive as that of biodiversity.

An example of how a new scientific trend is reflected in natural history museums in this novel structure is the consolidation which took place in the 20th century of ecology as a scientific procedure. According to Van Präet (1989), at that time studies relating to a species no longer focused on the organism per se, but on its relation with the environment. In order to exhibit this complexity, museums used new resources such as dioramas in order to exhibit to the public a representation of nature, including among

other aspects new values such as conservation and biological relations that went beyond the diversity of organisms (Van Präet, 1989). In the present survey, we analysed these objects as important milestones in the change of natural history museums into educational places in which the intention of teaching and divulging biological concepts was materialized.

Dioramas: a brief history and its educational potential

The term diorama comes from the Greek with *dia* meaning "through" and *"horama*" "to see". It emerged in the theatre in the early 1800's when theatre professionals built sceneries with a translucent structures in order to create greater realism or include more details to the production. Its migration to museums originated in the need to exhibit a representation of the natural environment to visitors. This need was resulted from the increased focus on ecology in the scientific environment as discussed in the preceding. However, in order for the diorama to become a viable museum exhibition tool, a convergence of factors that would enable its success was necessary, such as a specialization of taxidermists and painters geared to the construction of these devices. In short, the emergence of dioramas brought to museums a mixture of professionals with new profiles for a new way of exhibiting in detail the richness of life and complexity of the environments that science was studying.

Since then, dioramas have been widely disseminated in museums and as a result have been attributed different definitions. The literature that seeks to define dioramas likens them to the idea of representation (Lurie, 1983; Shon, 1987; Asensio & Pol, 1996; Ash, 2004; Breslof, 2005). We also point out that for some authors this representation includes the real object, the proper specimen, whereas for others this aspect is not so evident; however, they all underscore the importance of the scale of the objects that are presented in their real size.

Regarding the impact on the public, writers point out that in addition to an environmental representation, dioramas played an important role in reminding the public to preserve nature as well as enabling contact with the environment that perhaps many of these people have never come across.(Ash, 2004; Breslof, 2005; Quinn, 2008).

The intention to reach people is a strong indication of use of dioramas as educational objects in museums. In Ash's opinion (2004), the intention to educate people all over the world is the main motivation for existence of these resources.

> *Learners are encouraged by dioramas to observe, point at, seek more information and raise questions. As they start to link their own experiences lived with the artefacts in the dioramas, they can personalize concepts such as*

> *conservation of habitats and species. All this through observations, questions, explanations and other processes.* (Ash, 2004, p.84-85)

In Ash's opinion, dioramas promote an interactivity of visitors with the scientific aspects involved because according to her the behaviour of an observer is similar to how a naturalist observes a new environment. Quinn (2008) corroborates this view in his comment about the proximity of a diorama with the natural environment and what this may arouse in visitors. In Quinn's (2008, p. 1) opinion this potential is the result of the exactness with which a diorama represents an environment. "This is possible because dioramas bring more faithful representations than zoos, for example, they re-create the space where organisms are found more precisely".

However, authors like Van Praet (1989), bring up some aspects that put dioramas in another perspective. In his opinion, the ecological conceptions that the public may construct when they observe a diorama are much closer to those of the exhibition developers than those of scientists.

As described in the preceding, the intention of educating visitors through dioramas is ubiquitous. However, in the present study we observed that although they appear to be static objects, some visitors believe that dioramas are interactive, reinforcing even further their educational role. This characteristic is believed to lie in the potential to transpose and/or "take" the visitor to the natural environment reproduced there. The combination of scientific and artistic knowledge aiming at giving greater relevance to dioramas is also a strong indication that this exhibition form was conceived for educational purposes. The question whether dioramas reflect what science produces, or whether they are only recreations to entertain and educate the public reinforces even further how important they are for museums, and for us are a significant indication of the educational intention behind them. From this perspective, it is important to analyze the didactic transposition process of scientific knowledge into the knowledge mediated by museum exhibitions especially in the development of dioramas.

Didactic transposition in museums or museographic transposition

In her doctoral dissertation, Marandino (2001) studied the issue of transformation and production of knowledge in non-formal educational spaces such as museums. In continuation of this investigation theme, she has developed other works with the aim of consolidating the idea that these educational spaces have their own epistemology for production of knowledge in the field of education (Marandino, 2004; 2006).

In a literature review informing her study, Marandino (2001) showed that some authors acknowledged the presence of didactic transposition in museums, although none of them analysed the transposition processes to the extent that Yves Chevallard (1991) did in school contexts. Simonneaux & Jacobi (1997), using Chevallard's work (1985),

proposed the term museographic transposition in their study of the production of posters at a biotechnology exhibition. Here, the authors conducted a formative evaluation of a biotechnology exhibition and showed that the museographic transposition is a process that involves different elements such as space, language, concepts and texts.

Asensio & Pol (1999) described exhibit transposition as the complex adequacy whereby scientific knowledge goes on to be exhibited and received by the public at an exhibition. The authors clearly state that when studying didactical transposition in museums, it is important to take into account the characteristics of these locations because they are distinct from schools.

Marandino (2001) concluded that scientific knowledge is just one of the various types of knowledge involved in the construction of science museum exhibitions. She further states that organizing exhibitions is a game of power between the various types of knowledge involved in the production where some are legitimate and others are not.

Another study that addresses transposition of scientific knowledge in museums is that of Sousa *et al.* (2002). The aim of this research was to investigate the transposition of scientific knowledge for two exhibitions at the Museum of Astronomy and Related Sciences (Museu de Astronomia e Ciências Afins [MAST]). The authors were guided by the following questions: What are the steps in the process of museographic transposition? How do we establish the relationship between knowledge to be mediated and the communicational resources in the process of museographic transposition? The authors recorded how selected concepts were treated in the scientific reference knowledge and also how these concepts were exhibited. In addition, they studied the observations made by families who visited the exhibitions and conducted interviews with them.

In light of the preceding discussion of knowledge transformation in exhibition development, we asked ourselves what led to the belief that dioramas undergo transposition process? At first, as shown, it was clear that dioramas are used as educational tools in museums. The history of the museums reveals the educational rationale for introducing dioramas in exhibitions: as a way to contextualize the organisms and the environment and facilitate the comprehension of the biological information to the public (Van-Präet, 1989).

Using the anthropological theory of didactics as reference to understand a diorama as an educational tool, one could say that this object has a *didactic organisation* – a praxeology (Chevallard, 2007; Artigue and Winsløw, 2009). In our case, as the diorama is about biodiversity, is possible to identify parts of its praxeology. As Chevallard (2007:133) points out:

> *A praxeology is essentially made up of two parts, the* praxis *part and the* logos *part. Each part in its turn consists of two components. The praxis part is the*

> *union of a* type of task *(such as solving quadratic equations, blowing one's nose, composing a fugue) and a* technique *– a way of doing – which purportedly allows one to carry out at least some tasks of the given type – those in the 'scope' of the technique. The logos part is the union of a whole set of notions and arguments arranged into a more or less rational 'discourse' (logos), the so-called* technology *of the technique, which is intended to provide justification for the technique.*

In the case of biodiversity dioramas seen as praxeologies, one could say that the *praxis* part is composed by a task – expose the diversity of organisms and environment – and a *technique* – knowledge about animals taxidermy and plants conservation, woodwork, plastic art, painting, how to write a label or a panel. The *logos* part is composed by the rational discourse of biodiversity – which, as we will see, is not homogenous – and the *technology* – the knowledge from the fields of museology/museography, communication, design, arts, which is provide justification to the technique.

The production of a diorama is a praxeology, which involves many techniques related to the way the objects are prepared – animal taxidermy, conserved plants, painting of the environment or ecosystem. In fact, there is a distance between the organisms intended for scientific research produced by museums, and the organisms used for design of dioramas since the production of these latter is subject to the influence of exhibition related constraints, something that does not happen with material intended only for collection.

These aspects mark the complete dissociation between research that is collection oriented and research with mediational and educational purposes (Van Präet, 1989). Thus, dioramas are kept apart from specific interests of scientific research and closer to those that seem to be more targeted towards public exhibition. However, authors like Quinn (2008) and Ash (2004) are clear when they state that what makes dioramas effective in representing an environment results from information obtained from scientific research. This aspect emphasises the important link with scientific knowledge and at the same time distances the diorama from it because of the educational and dissemination objectives of the exhibitions.

In other words, to create a diorama is to be concerned with both scientific and educational questions – logos and praxis. This characteristic – the dual focus on educational apprehendability and scientific rigour – located in the development process of a diorama, provides evidence of the existence of a process of transformation of knowledge. A possible conflict of interests may exist regarding what researchers and educators perceive as being more relevant to exhibition. This conflict may in turn ensure something similar to Chevallard's (1991) notion of epistemological vigilance in the development of a diorama. Thus, those actors – researchers and teachers – participate, among others, in the noosphere of the museum exhibition which is regulated by cultural, science and technology and educational policies from state, city or region, the history of

the museums and of each institution, and other elements (Marandino, 2001) – all of which represent the levels of didactic determination (Artigue and Winsløw, 2009).

Biodiversity in scholarly knowledge

One of the main aspects in the study of didactic transposition is to outline the origin of knowledge – scholarly knowledge. It is important to outline that, as Chevallard (2007:132) proposes, the knowledge should not be seen as something homogeneous, isotropic or unquestionable. However, many teachers seem to hold this view. Understanding that scholarly knowledge is epistemologically heterogeneous and recognizing political, ideological, sociological and cultural influences on it is a way to demystify this idea.

As we have seen, scholarly knowledge in our research represents the discourse of scientists who work with research on biodiversity and the books and manuals used in higher education which seek to define this concept. The present survey identified at first that biodiversity is expressed both in conceptual terms as well as in relation to the values attributed to it. Furthermore, we analysed the relationship between what is found in the studied literature and the conceptions of interviewees in relation to both biodiversity concepts and values.

We constructed a categorization scheme regarding the definition of biodiversity in the texts consulted from books and manuals. A common characteristic is present in these works which is that of structuring the concept of biodiversity at the organization levels: genetic diversity; species diversity; ecosystems diversity. This perspective was also found by Oliveira (2005) in a historic survey of the concept. As a rule, the levels are interlinked and structured hierarchically because they describe different aspects of the life system ranging from the most specific to the most complex level which addresses the relationship of organisms.

The values attributed to biodiversity refer, according to the texts studied, to the reasons that led us to be interested in biodiversity. We have identified that economic, ecological and conservationist values are the most recurring.

In contrast, the opinion of researchers is that the levels of biodiversity are one among many ways of conceptualizing biodiversity, or more generally expressing the magnitude of biodiversity rather than a structure more concerned with formal definitions. Another point that was expressed is that definitions do not always show all levels of biodiversity, nor did the interviewees emphasise the hierarchic nature of the term which is common in the literature.

Among the three levels of biodiversity studied, we identified the level of species as the most recurring in the discourse of researchers. However, when they expanded on their ideas and perceptions of what biodiversity is, the other levels were mentioned. In

relation to the values of biodiversity analysed in the interviews we found a slight emphasis on economic value. In one of the cases, the interviewee in his discourse associated the economic factor with that of conservation, where the former can trigger people's interest in the maintenance of biodiversity. One of the interviewees attributed cultural historical and social aspects as biodiversity values. He presented man as a creating and modifying agent of the diversity we know, outlining the different manners in which man relates to the environment. This aspect indicates how diverse the ways of attributing a value to biodiversity may be.

The effort made to identify how close or distant what we see in literature and what researchers who study biodiversity say is with respect to concept and values results from the need to express how our scholarly knowledge is configured..

Since various information sources may be employed for organizing an exhibition, we sought to reflect this variety by mapping several of them in order to characterise the nature of scholarly knowledge on biodiversity. Such sources may be scientific articles and academic manuals, reference texts and materials to be divulged, but also oral communication by researchers from research institutes, universities or even museums. The selected sources reinforced the existence of polysemy of the concept of biodiversity in the reference knowledge. In short, what we are assuming is that the idea of biodiversity is composed of different shades that are influenced by both scientific and social discourse.

The heterogeneity in scholarly knowledge was identified by Chevallard (2007) and other authors with respect to the social and historic construction of this knowledge as well as the influence of social practices in its constitution. According to Caillot (1996), in the school environment scholarly knowledge is not necessarily the only reference knowledge and that it can be formed, for example, by social practices that permeate this environment. To Chevallard, "(…) in social life, a *question* is raised, in some institution, and persons in that institution try to do something in order to provide an *answer* to that question. The question is not intended to belong to any established field of study – it can be anything relating to any social practice. The answer that is being looked for has the structure of a praxeology, or of a fragment of a praxeology, or is a piece of a praxeological complex".

The non-linearity of scholarly knowledge was emphasised by Marandino *et al.* (2003) where the authors' goal was to analyse the transposition of scientific knowledge especially with respect to the concepts of days and nights and seasons of the year for two exhibitions at MAST. One of the emergent points was that depending on the concept that was addressed, reference knowledge arises from "various areas of knowledge", which leads us to reflect on what this knowledge is since it does not always correspond to one single field of scientific production. The authors state that "...this survey seems to point to how important it is to consider the peculiarities of the

various areas of knowledge when seeking the knowledge of reference of certain concepts" (Marandino *et al*., 2003, p. 181).

Based on our analysis of the distances and proximities between texts that address biodiversity and conceptions of researchers with respect to the theme, we have identified that the aspects present in the scholarly knowledge corroborate what was evidenced in the works that challenge its homogeneity.

In relation to dioramas, our studies indicate that in this production, scientific knowledge on biodiversity undergoes transposition processes since the information contained in animals, plants and paintings in relation to biodiversity on exhibit is not the same as that contained in the scientific collections although they originated from it. The process of creation of a diorama produces didactic materials and accordingly, we have a process of transposition. Faced with the importance of dioramas in depicting biodiversity, it is appropriate to investigate how the concept has been addressed in these exhibition devices. Future research challenges aim at identifying whether these exhibition devices incorporate the different scientific meanings, if they emphasise some of them or if they present ideas and notions distinct from the scholarly knowledge.

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MUSEOGRAPHIC TRANSPOSITION: ACCOMPLISHMENTS AND APPLICATIONS

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Abstract. L'idée de transposition didactique se pose dans la recherche sur l'enseignement des sciences dans les contextes scolaires, mais il a intérêt aussi à des contextes d'apprentissage informels comme les musées. Durant la dernière décennie, des chercheurs du musée ont utilisé le cadre de la transposition muséographique pour étudier comment les expositions dans les musées sont créés. Le cadre a progressivement développé dans trois directions qui mettent l'accent sur l'épistémologie, la sémiotique et la sociologie, respectivement. Nous passons en revue les travaux existants sur la transposition muséographique pour illustrer ces trois directions et de discuter les mérites de chacun d'eux.

Abstract. La idea de transposición didáctica se origina dentro del área de investigación educativa en ciencias, en el contexto escolar, pero tiene tambien relevancia en contextos informales de educación, como museos. En la década pasada investigadores de museos usaron como base la transposición museográfica para estudiar la forma en que las exposiciones eran creadas. Esta base teórica se ha ido desarrollando, gradualmente, en tres abordajes enfocados en la espistemología, la semiótica y la sociología, respectivamente. Hacemos, aquí, una revisión de los trabajos existentes en el área de transposición museográfica, para ilustrar estos tres abordajes y para discutrir los méritos de cada uno de ellos.

Abstract. The idea of didactical transposition arose in science education research in school contexts, but has relevance also to informal learning contexts such as museums. In the past decade, museum researchers have used the framework of museographic transposition to study how museum exhibitions are created. The framework has gradually developed in three directions which focus on epistemology, semiotics, and sociology, respectively. We review the existing work on museographic transposition to illustrate these three directions and to discuss the merits of each of them.

1 Introduction: Why study knowledge transformation in museums?

In research on formal science education, the theoretical idea of didactical transposition originally arose as a response to the inability of psychology to adequately address the practical problems of teaching and learning, and a resulting focus on knowledge as the variable of interest in educational systems (Chevallard, 2007). The main thrust of the notion of didactical transposition is that the knowledge developed by scientists in their research undertakings rarely maps exactly onto the design parameters in terms of which practical teaching action has to be planned. As a result, for

science to articulate with practice, a deconstruction and reconstruction of the knowledge in question is required (Layton et al., 1993). Accordingly, knowledge was seen not as having a definite and 'true' substance, but as something that is constructed, transformed, and *transposed*. Didactical transposition deals with the trajectory of knowledge in a process of making it teachable, and includes questions such as: Where does the knowledge come from? How, and by who is it shaped? What is its degree of effectiveness in promoting learning? (Chevallard, 2007).

Questions such as these are relevant also in informal science education contexts such as museums, science centres, zoos, etc. (in the following designated simply as 'museums'). Museums define themselves as places of learning (eg. Exploratorium, 2006; Experimentarium, 2002) and just as in formal science education contexts, museums create teaching environments, mainly exhibitions, on the basis of certain bodies of scientific knowledge which they wish to mediate to their visitors. It could even be argued that the didactical transposition that takes place in a museum context is *more critical* than that which takes place in a formal education context because one of the most important products of the transposition in a museum – the exhibition – is usually relatively static while the product of transposition in a school context may be continuously adjusted by the teacher according to the needs of the learners.

Accordingly, we argue that the study of the didactical transposition that takes place in museums is a necessary and worthwhile undertaking if we as researchers are to produce results than can improve teaching practices (i.e. exhibition development practices) in a way that can potentially affect the learning outcomes of these environments. In the following, we review the studies that have applied the notion of didactical transposition to informal education contexts in order to draw out two main lines of research which we feel are fruitful. We then proceed to outline some interesting perspectives of this work.

2 The museum as an educational place

As informal education spaces, museums promote and organize many kinds of activities and events for a diverse audience with the purpose of increasing and improving scientific culture and literacy (Lucas, 1991; Bradburne, 1998; Beetlestone et al., 1998). The educational activities that take place in the museum are characterized by their relationship to the elements *space, time* and *objects* (Van-Praët and Poucet, 1992). The exhibition is the primary medium for the educational endeavors of museums and is typically the result of the work of many teams involving professionals from many areas of knowledge (scientists, museologists, educators, communicators, designers, artists, etc). Through exhibitions, it is possible for visitors to learn concepts, participate in activities, experience moments of fruition, contemplation, leisure and, accordingly, it is important to understand that the narrative proposed by them is a fundamental step towards the fulfillment of education and scientific public communication objectives in museums.

The characteristics of exhibitions have been widely studied (Dean, 1994; Davallon, 1999; Schärer, 1999). Davallon (1988) presents the challenges of exhibition development by considering it a process in which representation occurs when the scientific discourse (the source knowledge) is transformed to the vulgarisation discourse (the target knowledge). He analyses this representation process using a semiotic interpretation which considers the dimension of *space* in which the

vulgarisation occurs. He suggests that the vulgarisation in the production of an exhibition is not merely a translation process, but a transformation one. In this transformation of the source-text into a target-text, another *object* is produced – the exhibition.

Ramos (2004) affirms that exhibiting something is to make it viewable by removing it from its original location. He says that displaying an object is *topography violence*, an act of taking the object from its place of use and conferring to it a dimension of spectacle. Exhibiting, to him, is an exercise of relocating the object.

In our work we focus on understanding and analysing this transformation process, both in epistemological and museographical way, in the production of an exhibition. The concept of didactical transposition and, specifically, museographic transposition, is our primary theoretical tool to study the production of exhibitions in museum.

3 The development of the model of museographic transposition

Despite being known in formal science education contexts since the seventies, the didactical transposition framework was first seen in an informal science education context in the mid-nineties. Early applications of the framework mainly took the form of the acknowledgement of the existence of a knowledge transposition. This was the case, for example, in a study by Allard et al. (1996) where the authors acknowledged the occurrence of a tacit knowledge transposition in the discourse produced by museum guides, and argued for improving this discourse by making the transposition deliberate and adapting it to the cognitive abilities of the learners in the target group. Allard and colleagues thus advocated the prescriptive model of transposition shown in Figure 1A.

The term *museographic transposition* was coined about a year later by Simonneaux and Jacobi (1997). Just as didactical transposition is the transformation that occurs during the process of creating taught knowledge from scientific knowledge[i], museographic transposition was defined as the transformation of scientific knowledge into knowledge taught in an exhibition (Simonneaux & Jacobi, 1997). The term *museographic* refers to the visual presentation form proper to the museum, i.e. the exhibition, which may consist of a range of objects and three-dimensional models as well as illustrations and text. The authors, however, limited their discussion mainly to the transposition of knowledge as text and the linguistic choices made in this transposition.

In their study, Simonneaux and Jacobi (1997) investigated the museographic transposition of an object of knowledge from the field of biotechnology. The point of departure was an object of biotechnological knowledge and its articulation in scientific journals. The 'taught knowledge' was the museographic manifestation of this knowledge in a series of exhibition posters consisting of text and photos. The study thus assumes a single transposition process from the reference knowledge in the scientific discourse to the knowledge expressed the exhibition milieu (Figure 1B) but emphasise the importance of avoiding the dogmatisation of knowledge by transposing not only the scientific knowledge itself but also the characteristics of the origin of this knowledge (cf. Astolfi et al., 1997). The transposition model implicitly advocated by Simonneaux and Jacobi (1997) (Figure 1B) is accordingly one that includes the context and social setting of a given object of knowledge.

The full implication of the term *museographic* transposition was appreciated by Asensio and Pol (1999) when they addressed the complexity of museum exhibitions by discussing the role of objects as mediators of knowledge. Specifically emphasised by these authors was the importance of objects as interpersonal mediators between the people who produced them and the people who contemplate them, an emphasis which marks the first use of semiotics[ii] in the body of work regarding museographic transposition.

Asensio and Pol also pointed to the importance of scientific rigor in research collections, and of the adaptation of domain-specific knowledge - not just applying general findings from psychology, but new theoretical contributions and context-specific studies of the real issues of museums and exhibitions, calling attention to the evolution of didactics – an evolution which has accumulated specific knowledge that may guide the use or non-use of certain types of technologies and other contributions, the avoidance errors, and the use of certain teaching materials and experiments. According to these authors, this specific didactical knowledge may assist in the adaptation and simplification of complex content, minimising the risk of losing the relationship with the reference discipline or falling into the trap of superficial popularization.

Marandino (2001) studied the characteristics of the discourses and areas of knowledge that participated in the construction of the expositive discourse in biology exhibits in order to understand what happened to the scientific knowledge when it was exhibited in museums. The theoretical foundation of the research was an articulation of didactic/museographic transposition concepts and the concept of recontextualization (Bernstein, 1996). Also, the concepts of noosphere (from Chevallard, 1991) and recontextualization campus (from Bernstein, 1996) were used to understand how the actors and the institutions which relate to the areas of science, education, communication and museology participate in the selection and production of the exhibition discourse.

Marandino (2001) studied five museums using observation of the exhibition, interviews with the staff responsible for them, and document analysis in a qualitative approach. The data were aligned with the theoretical framework based on the concepts of museographic transposition and recontextualization and viewed in light of a review of museum research literature. This process characterized the elements of institutions, areas of knowledge and actors that influenced the production of the expositive discourse.

This analysis showed that, in the process of recontextualization, the biological discourse was integrated into the logic of the expositive discourse and participated in the negotiation that occurred in the development of the exhibition, bringing with it its histories, its structure, its contents and its procedures. However, beyond this process, other discourses also entered the negotiation game. A selection process took place in which some elements were left out and new approaches were taken into account with different scopes than that of the original discourse. Depending, among other factors, on the conceptual options - political as well as institution-historical - some voices took part in this discourse negotiation more intensely than others, thus imposing their own logic, structure, procedures and contents.

The results showed that the expositive discourse had a similar behaviour to Bernstein's (1996) pedagogic discourse, by displacing other forms of discourse based on its own principles and

objectives and assuming the characteristics of "recontextualizing" discourse. This means that the expositive discourse had specific characteristics, distinct from the scientific discourse, which resulted from the relationships between time, space and the objects in the museums. Accordingly, the study affirmed that in the process of museographic transposition, the knowledge established specific relations with the elements which behave in a particular way in museum contexts. Also, the knowledge which was selected to be presented in the exhibition passed through a negotiation process (which is epistemological but also political) that involved the professionals, the different areas of knowledge, the history of the museum and of each particular institution and other social actors and institutions from the museum noosphere or recontextualization campus (Figure 1D).

Contemporaneously with the study by Marandino, Gouvêa de Sousa et al. (2002) took up the museographic transposition model from Simonneaux and Jacobi, and as Asensio and Pol, they added a layer of complexity to the model in their discussion of the logics of discourse and space[iii] that governed the transposition process in the production of an exhibition. This work was based in part on the semiotics ideas from Davallon (1999). According to Gouvêa de Sousa et al., the point of departure for the transposition process was knowledge from science text books, and the logic of discourse governed the selective reduction of this knowledge while the subsequent implementation of the knowledge into the exhibition was controlled by the logic of space. The authors thus emphasised the fact that the transposition process changed not only the structure of the knowledge but also its modality; from being mainly textual, it was reified in space, objects and activities in the exhibition. Further, the authors implicitly acknowledged the presence of an intermediate step of transposition, namely an exhibition planning document; however, the implications of the presence of this document for the transposition process were not discussed (Figure 1E).

The exhibition planning document was explicitly introduced into the model by Mortensen (2009) who found the *curatorial brief* to be an important intermediate stage in the knowledge transposition that occurs in exhibition development (Figure 1F). Mortensen found the curatorial brief to extract and transform a scientific object of knowledge into a description of a didactical environment, a role which in some ways is similar to that of a teaching programme in a formal education context. In both cases, the focus of the document in question is to transform knowledge into suggestions for didactical activities (cf. Astolfi et al., 1997); however, unlike in formal education contexts, in the museum context the authors of the document are often identical to the actors that implement the didactical activities – the exhibition. This continuity of the actors involved in the museographic transposition should arguably ensure a corresponding continuity in the knowledge transposition process from scientific knowledge to implemented exhibition, yet Mortensen found a considerable relaxation of epistemological vigilance in the second stage of transposition. The introduction of an intermediate stage of knowledge transposition, namely that of the curatorial brief, may thus help pinpoint the location and cause of the relaxation of epistemological vigilance in the exhibition development process reported in the literature (cf. Gouvêa de Sousa et al., 2002; Belaën, 2005).

Another development of the model of museographic transposition was the inclusion of the idea of a reference model from research in formal education contexts (e.g. Barbé et al., 2005). Earlier uses of the notion of transposition had labelled the knowledge which was the point of departure as the

reference *knowledge* (see Figure 1), but in the new usage, the reference *model* consisted of an epistemological model of a given body of knowledge, a model which is distinct from the scientific knowledge which was the point of origin for the transposition or indeed from the knowledge present at any step of the transposition (Mortensen, 2009). The reference model is constructed empirically

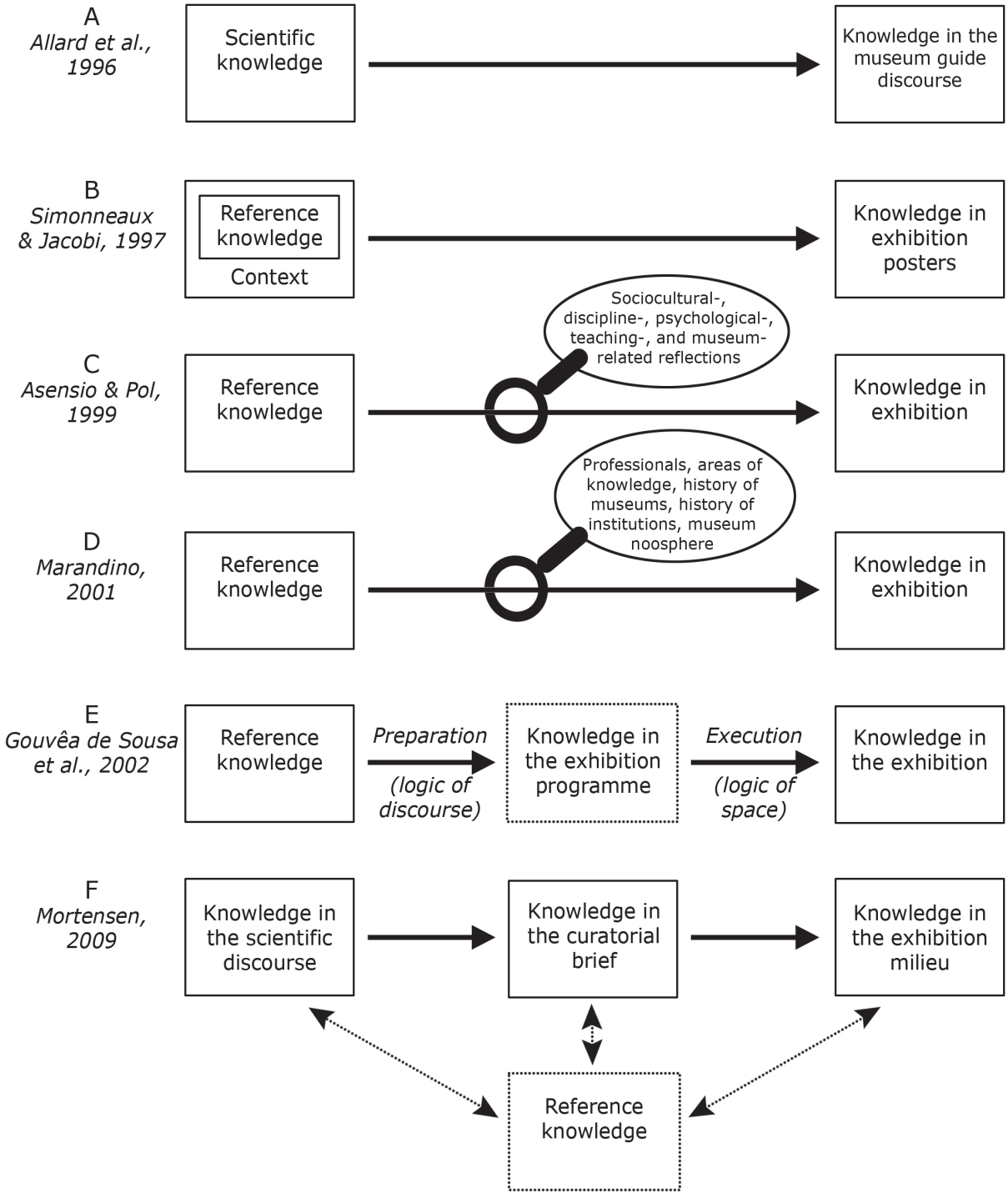

Figure 1. *Our conceptualisations of the models of museographic transposition used in research from 1996 to today.*

to encompass, interpret, and analyse the object of knowledge in each of its transpositional stages and modalities and accordingly serves as a broader didactical map (Barbé et al., 2005), thereby removing the focus from the scientific knowledge as the standard to which subsequent stages of transposed knowledge were compared.

In sum, the model of museographic transposition has been gradually developed and it is possible to identify some approaches on the way this framework is been used on the informal education museum context.

4 Three emergent approaches in museographic transposition research

Three approaches emerge from the body of work described above: an **epistemological** approach that emphasises *knowledge* in the various forms it takes in the transposition process; a **semiotic** approach that emphasises the *forms* that the knowledge takes in the transposition process, related to some of the elements that are present in exhibition context such as objects, time and space; and a **sociological** approach, which focuses on the historical, social, political and cultural influences that participate in the production of the exhibition . All three approaches are to some extent present in all the studies on museographic transposition outlined here; however, we found that one of the approaches was usually the main focus as described in the following.

The *epistemological approach* can be identified in the works of Simonneaux and Jacobi (1997), Mortensen (2009) and Gouvêa de Sousa et al. (2002). In these cases, the concept is the central element of the research and studies focus on what happens to the central concept, what other concepts are related to it in the reference knowledge, and what is the difference when it becomes exhibit knowledge. We designate this approach epistemological as it deals with the difference between the network of concepts in the scientific knowledge and the new relationships that are created – another network – in the exhibit. The approach does not ignore the different modalities of knowledge in the transposition process, but rather, it accounts for them by 'translating' them into a common modality – as illustrated by the application of the reference model in Mortensen (2009).

The *semiotic approach* is mentioned in the work of Asensio and Pol (1999) and can be identified in the research of Gouvêa de Sousa et al. (2002) and Marandino (2001). This research takes into account the elements from the exhibition – such as objects, time and space – to understand the process of museographic transposition. Here, the working hypothesis is that those elements influence directly the way that the exhibit knowledge will be shown, and, consequently, the way that the selection of the concepts and ideas of the scientific knowledge will happen.

Finally, the *sociological approach* is the perspective assumed by Marandino's (2001) work, as she studies the historical, social and political elements that influence the constitution of the expositive discourse. By analysing the history of the museums and the corresponding changes in the educational objectives, and by considering the influence of the social institutions and their actors on

the definition of the role of the museums today, it is possible to identify the increased educational role of those places. Also, considering the history of each institution, their mission and the characteristics of the people who were involved on the production of the exhibitions, it is possible to realize the elements of the museum noosphere. As the perspective of the work of Marandino (2001) tries to understand the way institutions, areas of knowledge and social actors influence the production of the exhibition – what she called a power game – it was necessary to articulate the theory of museographic transposition to the theory of the construction of the pedagogic discourse, from Bernstein (1996). The similitude and distances between the concepts of didactical transposition and noosphere from Chevallard (1991) and recontextualization and recontextualization campus, coined by Bernstein (1996), was analysed. One difference that had been identified on the two concepts is that how they deal with the role of the social and political influence on the knowledge transformation or on the production of pedagogical knowledge. To Chevallard, the academic influence or power is bigger then the social one, witch is coming from the school, teachers, community, parents, or any other social group. On the other hand, to Bernstein, the regulative discourse, based on the social order, is powerful then the academic one and, in fact, it regulate the scientific knowledge (instruction knowledge). So, the concept of noosphere seems to not consider the powerful game – political, ideological, sociological, cultural – as the concept of recontextualization campus does. (Marandino, 2004).

The theoretical reference elaborated by these authors helped to study how five science museums deals with the production of the expositive discourse, selecting some discourses from some knowledge areas and taking the voice form others. In that game, which is also a social and political one - the scientific knowledge sometimes is central determinate the final exhibition discourse, but, in other situations, it's not to powerful and lost space to others discourse – as the educational, communication, museographic ones.

5 Perspectives

The lines of research described may provide fruitful ideas about some of the central didactical questions in informal education contexts such as museums (which are similar to those of formal education contexts such as schools): Where does the knowledge come from? How, and by who was it shaped? What is its degree of effectiveness in promoting learning? The three different approaches present in the research on knowledge transformation in museums each center on one of these questions; thus, the epistemological approach deals mainly with the question of where does the knowledge come from, the semiotic approach considers the effectiveness and mechanisms of the produced milieu in promoting learning, and the sociological approach focuses on how and by whom the knowledge is shaped in its trajectory towards the exhibition. Each of the three approaches has its own merits, and as is always the case in research, the appropriate approach depends on the specific research question. Regardless of the approach chosen, using the museographical transposition framework to answer questions of an epistemological, semiotic, or sociological nature will contribute to a profound understanding the didactics of the informal education field showing, on one hand, the behavior of the *knowledge* in the curatorial process, in the exhibition milieu, and in relation to the public. On the other hand, it could also give valuable information about how the

museographic elements participate in the *process* of didactical transposition that occurs in the exhibition production and about the social actors and institutions which constitute the museum noosphere.

Finally, more recent developments in the Anthropological Theory of Didactics include the notion of praxeology as the basic unit of human activity. In an educational setting, considering the teaching intervention in terms of praxeologies may help to achieve an understanding of the levels of didactic determination in play, and vice versa (Artigue & Winsløw, 2009). A similar approach to the analysis of the museum teaching intervention – the exhibition – could provide valuable insights as to the interplay between the levels of didactical determination in an exhibition setting; however in the present case, the reviewed papers did not offer enough details for the authors to provide such an analysis. Work is under way, though, that employs these notions in an exhibition setting (Mortensen, 2009b).

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[i] The term ‘scientific knowledge’ is used to denote that which Chevallard (1991) designates as ‘savoir savant’.

[ii] Semiotics is a general theory of signs and symbolism, and is usually subdivided into the branches of pragmatics (the relation of signs to their impact on those who use them), semantics (the relation between signs and the things they refer to), and syntactics (the relation of signs to each other in formal structures) (Webster's encyclopedic unabridged dictionary of the English language, 1989).

[iii] The authors include ‘gesture’ as the logic which governs the mediation of knowledge from exhibition to visitor; we do not include this step in our review of the transposition model here.

MARANDINO, M.; MORTENSEN, M.. Museographic transposition: accomplishments and applications. In: III International Conference on the Anthropological Theory of the Didactic, 2010, Saint Hilari Sacalm. III International Conference on the Anthropological Theory of the Didactic. Barcelona: Ingenio Mathematica, 2010. v. 1. p. 323-332.

Éducation et communication dans les bio-expositions des musées de sciences du Brésil

M. Marandino

Ces dernières années, les études portant sur les expositions et/ou les activités éducatives des musées se sont intensifiées et sont devenues de plus en plus un domaine de production de connaissance. Une bonne partie des enquêtes réalisées concerne le public visiteur de ces lieux, soit pour connaître ses intérêts, impressions ou connaissances, soit pour évaluer l'efficacité de l'offre muséale du point de vue du loisir a de l'apprentissage.

Les expositions sont les éléments de communication fondamentaux des musées. Elles **3ot** pour fonction de diffuser ou de promouvoir les savoirs accumulés sur les collections à travers la recherche scientifique. Leur processus d'élaboration est étudié et discuté depuis longtemps et certains auteurs parlent même d'une «muséologie scientifique» <Wagensberg, 2000), tout en privilégiant une forme particulière de présentation des sciences naturelles et exactes dans les musées.

Le travail présenté ici émane d'une recherche sur le processus d'élaboration des expositions des musées de sciences dans le but de caractériser les éléments, les savoirs et les discours qui participent à la constitution de ce moyen de communication (Marandino, 2001). Son point de départ est la supposition que, dans le processus de muséalisation 'Bruno, 1996), il y a une production de discours ayant pour base l'idée que l'exposition est un médium de l'espace tout à fait spécifique.

Dans cet article, nous allons étudier la forme que prennent l'éducation et la diffusion de la science dans les musées brésiliens de biologie. Espaces non formels d'éducation, les musées ont des particularités qui concernent les formes de diffusion du savoir scientifique. Pour étudier leur rôle en tant qu'espaces d'éducation, il est indispensable de comprendre comment les expositions sont structurées, le genre de contenu qu'elles offrent et de quelle manière elles l'abordent, sans oublier le rôle d'éléments tels l'espace, le temps et l'objet (Van-Praet et Poucet, 1992).

Approche méthodologique

La recherche a été élaborée à partir d'une approche méthodologique qualitative. Les données ont été obtenues au moyen d ' **interviews stmi-structurées,** proposées à des concepteurs et à des coordonnateurs d'exposition ; d'**observations d'expositions,** appuyées sur un cadre élaboré à partir de critères préétablis, et d'**analyses documentaires.** L'étude a porté sur les expositions de cinq musées, quatre étant situés dans la ville de Sào Paulo : le Musée de Zoologie, le Musée d'Anatomie Vétérinaire, le Musée Océanographique et la Estação Ciência (Oiseaux urbains. Station Butantã et Aquarius)[1]; et un cinquième à Rio de Janeiro : Museu da Vida, Espaço Biodescoberta. Il a ainsi été possible de caractériser le processus de construction des expositions en identifiant ses propositions conceptuelles et ses éléments constitutifs, puis d'approfondir le thème de l'éducation dans les musées.

Pour les différentes expositions, ont été observés, entre autres, l'espace physique, les aspects graphiques, le design, la communication visuelle, les textes et leurs langages. L'analyse est fondée sur l'exposition en tant que moyen d'éducation et de communication dans les musées.

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[1] Estacão Ciência esl un centre de sciences présentant plusieurs thèmes scientifiques. Ici, nous nétucno que ses expositions de biologie.

La recherche sur l'éducation et la communication dans les musées

La nature et le rôle éducationnel des musées se sont modifiés avec les années, et les acti¬vités correspondantes se sont diversifiées. Selon Hooper-Greenhill (1994a), le travail des éducateurs des musées s'est élargi. Il comprend à présent le développement d'expositions et la réalisation d'études de publics aussi bien que l'organisation et la réalisation de séances éducatives.

En ce qui concerne les orientations éducationnelles prises par les musées, il est pos¬sible d'identifier celles qui ont une réelle influence. Hooper-Greenhill (1994b) indique deux approches éducationnelles utilisées dans ces espaces. La première, positiviste oo réaliste, envisage épistémologiquement le savoir comme extérieur à l'apprenti, comme un corps de savoir absolu, défini par ce qui peut être observé, mesuré et objectivé. La seconde, constructiviste, envisage le savoir comme un construit à partir de l'interaction de 1'«apprenant» avec l'environnement social et, alors, la subjectivité fait partie de cette construction. De telles approches ont influencé la compréhension du rôle de l'éducateur dans les musées.

Cazelli, Gouvêa, Franco et Sousa (1997, p. 3) signalent que l'investigation éducationnelk dans les musées de sciences s'intensifie de manière particulière dans les années 197C «dans le but général de révéler les processus d'apprentissage vécus par les visiteurs, c'est-à-dire la qualité de ce qu'ils apprennent et la manière dont ils le font». Falk et Dierkinj (1992), par exemple, soulignent la difficulté d'étudier l'apprentissage dans les musées er montrent que la plupart des recherches sont faites en dehors de ceux-ci. Ils soulignes la nécessité de créer un modèle pour analyser les interactions qui se produisent dans les espaces museaux, ainsi que la dimension sociale de l'apprentissage.

Par ailleurs, Hooper-Greenhill (1994a) indique que les différents groupes de visiteur} possèdent des attentes différentes en ce qui concerne l'apprentissage. Elle souligne que attentes visent souvent les objets et que le «dialogue» entre ceux-ci et l'observateur par prendre des formes variées et porter sur une multitude de sujets.

Quant aux préoccupations concernant la communication, Hooper-Greenhill (1999a) affirme qu'une grande partie des expositions sont encore élaborées sans prendre a compte le public qui les visitera. Ainsi il y a, selon Hooper-Greenhill, deux approcha de communication dans les musées: l'approche de transmission et l'approche culturei Le modèle de la transmission perçoit la communication comme un processus d'envoi de messages ou d'idées d'une source d'information à un récepteur passif. Ce modèle pié\a» quand le musée ne se pose pas de question sur les expériences de son public, quand il wt fait pas d'évaluation, de consultation, ou quand il ne réfléchit pas sur ce qu'il a produr.

Par contre, dans l'approche culturelle, la réalité est « moulée » par un processus continu de «négociation» des individus qui, à partir de leur expérience, construisent activement leurs propres signifiés. Dans ce cas, la communication est vue comme un processus d'échange, de participation et d'association; un processus éminemment culturel, qui crée le signifié au cours de la production de sens.

Les recherches sur le processus de production d'expositions ne sont pas fréquentes parmi les études sur les musées. Selon McManus (2000), cette absence d'études renforce l'approche unidirectionnelle de la communication avec les visiteurs et laisse les «bonnes expériences» dans l'ombre de la pratique quotidienne non publiée, ce qui n'augmente pas les connaissances des professionnels de musée. McManus insiste donc sur la nécessité de faire de la recherche sur ce sujet et d'observer des équipes en train d'élaborer des expositions.

Ainsi, on peut affirmer que, d'une part, les recherches réalisées dans les musées et qui sont basées sur des préoccupations éducatives et communicatives se soucient de comprendre comment le public interprète les expositions qu'on lui offre et apprend dans ces espaces. D'autre part, ces recherches n'ont pas eu pour sujet la production des expositions, même s'il s'agit d'un sujet important. C'est justement pour étudier la conception du discours expositif que la présente recherche a été développée. À partir des données qu'elle a fournies, il a été possible

d'identifier les approches d'éducation et de communication présentes dans les expositions des musées de sciences ayant pour thème principal la biologie.

L'unité d'étude utilisée dans cette recherche est l'exposition. Dean (1994, p. 1) affirme que les musées ont pour rôle de «collectionner, préserver, faire des recherches et exposer publiquement des objets». Ainsi, les expositions publiques sont l'un des éléments fondamentaux de l'identité des musées qui ont la mission de promouvoir un espace d'éducation et de réflexion. La recherche présentée ici est fondée sur l'étude de la production des expositions des musées à partir de la vision des professionnels concernés par cette activité.

À partir des références théoriques issues des recherches en éducation et en communication dans les musées et sur le thème de l'exposition en tant que sujet d'étude, nous avons analysé les espaces expositifs de cinq musées et discuté le «quoi», c'est-à-dire le contenu biologique présenté, «comment» ce contenu est présenté dans les musées, de même que l'orientation éducative et communicative de ces espaces.

Les expositions étudiées

Musée de Zoologie

L'exposition permanente du Musée de Zoologie[2] a été élaborée dans les années 1940 et n'a pas été modifiée de manière substantielle jusqu'à tout récemment[3]. Elle présente une importante collection d'histoire naturelle spécialement consacrée à la zoologie. Elle occupe un espace de 700 m^2. Le musée lui-même a pour but de conserver les collections zoologiques, de réaliser des recherches scientifiques et de promouvoir l'enseignement à plusieurs niveaux, en plus d'offrir des services à la communauté.

L'exposition permanente analysée dans ce musée exprime fondamentalement une conception de la biologie et de la muséologie propres aux **XVIII**[e] et **XIX**[e] siècles, car elle possède des caractéristiques physiques semblables à celles des musées traditionnels d'histoire naturelle. Selon les coordonnateurs de ce musée, il est possible d'identifier dans l'exposition le caractère «collectionniste» qui marque les collections d'histoire naturelle de cette période.

En outre, le mobilier de cette exposition est ancien, constitué d'armoires en bois et en verre avec des étagères semblables au mobilier des XVIII[e] et **XIX**[e] siècles. Dans cette exposition, coexistent dans le même espace un grand nombre de spécimens présentés dans des vitrines, distribués selon l'organisation systématique classique et ignorant, par exemple, les discussions actuelles dans ce domaine de la biologie. D'autre part, on a introduit dans l'exposition quelques dioramas dans le but de présenter les êtres dans le milieu où ils vivent, ce qui met en valeur les rapports écologiques.

Une grande partie des organismes est présentée exhaustivement dans les vitrines, avec beaucoup d'exemplaires du même groupe. Le choix d'exposer un grand nombre d'animaux, souvent des espèces d'autres régions du monde, indique le caractère universel et métropolitain de ce musée, comme l'a souligné Lopes (1997) en référant à la création des musées scientifiques au Brésil. En somme, cette exposition peut être considérée comme un exemple d'essai d'élaboration d'un «catalogue» de la nature, idée partagée par les naturalistes du *xvnF* siècle, mais incorporant, en même temps, surtout avec l'introduction des dioramas, des visions muséographiques et scientifiques nouvelles, propres au siècle suivant. Les recherches actuelles dans le domaine de la biologie, en particulier en zoologie, ne se caractérisent plus, comme aux siècles précédents, par la réalisation d'un « grand catalogue de la faune brésilienne ». Le travail des chercheurs de musée, selon les témoignages actueis, se fait dans une tout autre perspective.

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2 Le Musée de Zoologie a été créé en 1969, quand le Département de Zoologie du Secretaria de Agricultura do Estado de São Paulo a été transféré à l'Université de São Paulo. L'origine de sa collection est un don fait au Gouvernement de l'État de São Paulo par Joaquim Sertório en 1870, avec de nouvelles incorporations d'objets dans les années qui ont suivi (Uspiana Brasil 500 Anos, 2000; Lopes, 1997).

3 Cette exposition a connu une grande transformation de 1998 à 2002 et vient d'être rouverte au public.

Les chercheurs utiiisent en effet la taxonomie comme un outil d'investigation des raisons historiques et évolutives qui révèlent des modèles facilitant la compréhension de l'histoire de l'Amérique du Sud et de la région tropicale.

Les contenus abordés dans l'exposition concernent fondamentalement la systématique classique et la taxonomie, en plus de fournir, présentées sur les étiquettes, quelques informations sur le comportement et la biologie des animaux. Il y a quelques panneaux thématiques, comme celui qui explique l'anatomie des insectes. On peut considérer les dioramas comme des tentatives de présenter les êtres dans leur environnement. Il s'agit d'une stratégie attrayante, car elle apporte généralement de l'information sur la biologie, l'écologie et la bio-géographie, en plus de souligner certains aspects esthétiques des objets, car les dioramas sont des productions riches en détail sur les animaux dans leur habitat. En entourant les animaux de leur décor, les dioramas fournissent des informations supplémentaires à celles de la présentation taxonomique systématique.

Les objets de cette exposition - animaux conservés, taxidermisés, diaphanisés, etc-offrent plusieurs contenus sur la biologie et l'écologie des espèces. Par ailleurs, les stratégies expositives de médiation entre les objets de l'exposition et le public se limitent aux étiquettes. Toutefois, la compréhension de l'exposition par les visiteurs est une préoccupation des coordonnateurs actuels de ce musée.

L'exposition du Musée de Zoologie analysée ici ne fournit pas d'information sur la recherche biologique que l'on réalise dans ce lieu. Cet écart entre la recherche actuelle et l'exposition est le résultat d'une politique institutionnelle qui, pendant longtemps, n'a pas investi dans la diffusion de la production scientifique contemporaine au moyen des expositions. Les activités universitaires liées à la recherche biologique ont été privilégiées aux dépens des activités relatives à la muséologie, à la diffusion scientifique et à l'éducation du public visiteur.

Néanmoins, la mise en place, en 1998, d'un service éducatif par la création de la Division de la diffusion culturelle a été un pas en avant dans l'histoire de cette institution, dans le sens d'un élargissement de son rapport avec le public. Quelques actions ont été réalisées par le secteur éducatif, telles l'élaboration d'un feuillet, d'un site Internet et la réactivation de son «Bulletin interne». Dans la mesure où le musée se fait plus « visible», les sollicitations d'information de la part de la population augmentent. Un autre service, qui représente le plus grand investissement depuis sa création, est celui des prêts de matériel conservé, qui ont augmenté de façon importante. D'autres stratégies d'information sont en train d'être créées ou améliorées et ainsi le Musée de zoologie élargit son action dans la communauté.

Musée d'Anatomie Vétérinaire

Le Musée d'Anatomie Vétérinaire est à présent une section de la Faculté de médecine vétérinaire de l'Université de São Paulo (USP). Son exposition permanente est marquée, depuis son origine, par le fait que la collection servait aux cours d'anatomie comparée réalisés dans ce lieu. Composée de pièces anatomiques de différents animaux, la proposition initiale de ce musée consistait à montrer les objets nécessaires à l'étude de la matière.

En dépit de l'absence d'un projet muséologique formel, il est possible d'identifier des éléments qui ont constitué la proposition du Musée d'Anatomie Vétérinaire. On distingue différentes étapes dans son histoire.

En 1969, quand la Faculté de médecine vétérinaire s'installe sur le campus, le musée occupe les couloirs de l'institution, ce qui augmente la visibilité des objets exposés.

En 1984 le musée, déjà installé à l'université, se retrouve dans un grenier près de la Faculté. On introduit alors des modifications dans la forme de son exposition. Au début, la manière de présenter les pièces était influencée par les recherches scientifiques développées par les

professeurs et les chercheurs engagés dans la constitution du musée et préoccupés par la matière à enseigner.

La modification de l'exposition a été graduelle. D'une disposition d'objets fondée sur la présentation d'une collection de plusieurs exemplaires, l'exposition a commencé à montrer des préoccupations muséologiques avec l'arrivée d'un professionnel de ce domaine : *« (...) Il y a près de cinq ans, nous avons reçu la muséologue; et quand elle est entrée, il y a eu pour ainsi dire une révolution ici au musée»* (témoignage oral).

L'entrée de la muséologue dans l'équipe a provoqué quelques changements dans la structure de ce musée, non seulement dans la stratégie de communication de l'exposition, mais aussi dans la chaîne des opérations muséologiques, avec l'introduction d'activités de conservation et de documentation des objets. Dès lors, l'équipe a fait face au défi de présenter la collection sous la perspective de l'anatomie vétérinaire comparée, avec la préoccupation que la muséographie aide à la compréhension de cette perspective par le public. En outre, le changement du genre de public a été un facteur déterminant dans le* modifications intervenues ; la présence de nombreux écoliers a influencé les choix faits par le musée et l'a amené à se préoccuper de leurs besoins éducatifs.

Dans la mesure où la préoccupation pédagogique est devenue importante pour les coordonnateurs du musée, il a fallu élaborer des stratégies de présentation qui aident à la compréhension des objets exposés. On en a retenu une appelée: «regardez, arrêtez-vous, observez et comparez ».

Aujourd'hui, ce musée occupe environ 700 m^2 à la Faculté de médecine vétérinaire L'organisation de l'espace d'exposition est basée sur le classement des groupes d'animaux suivant un schéma propre à l'étude de l'anatomie vétérinaire, et non selon une logique évolutive. Dans chaque lieu, ou « niche » relative à un groupe déterminé, on trouve plusieurs spécimens ou parties anatomiques de carnivores, primates, oiseaux, bovidés, suidés et équidés. Il y a aussi des lieux «divers» où se trouvent des squelettes et/ou des organes d'animaux qui n'entrent pas dans les autres niches.

Les objets présentés dans l'exposition correspondant aux exigences de la médecine vétérinaire, leur organisation se fonde sur l'anatomie comparée. L'intention conceptuelle de ce musée est de présenter l'anatomie de différents vertébrés en établissant une relation entre leur structure osseuse et des aspects de leur adaptation à l'environnement. Les contenus traitent essentiellement du rapport entre forme et fonction, adaptation et anatomie comparée. L'exposition présente les caractéristiques morphologiques, taxonomiques et biologiques (habitat, alimentation, reproduction, classement, etc.) des animaux à travers la présentation d'organes, de systèmes et de squelettes, accompagnés d'informations sur la distribution géographique des êtres et les milieux d'où ils proviennent. Elle présente en outre les techniques de conservation utilisées (fixation, taxidermie, corrosion, diaphanisation, mulligan, térébenthine et macération), avec des commentaires sur leurs particularités.

L'exposition du Musée d'Anatomie Vétérinaire met donc l'accent sur une organisation disciplinaire de l'anatomie vétérinaire, c'est-à-dire basée sur l'organisation logique de cette discipline scientifique. Elle présente cette dernière au moyen d'un nombre élevé de spécimens, tout en offrant une série d'éléments qui semblent en désaccord avec cette orientation: des stratégies muséographiques différenciées, en général orientées vers la communication avec le visiteur. Les endroits où ces stratégies sont utilisées sont facilement repérables, par exemple, quand, au début de l'exposition, on encourage à « toucher » les pièces anatomiques, ou quand, plus tard, on encourage la réalisation de comparaisons entre les parties d'organes de différents animaux à travers la proposition thématique «regardez, observez, comparez».

D y a un secteur précis de l'exposition où les objets ont été organisés à partir d'un thème: «le cœur». À l'aide de panneaux contenant textes et images, on fournit de l'information sur ce thème et on expose plusieurs exemplaires de cœurs conservés à l'aide de techniques différentes.

Ainsi, l'exposition du Musée d'Anatomie Vétérinaire possède des éléments qui permettent de croire que l'on se préoccupe de fournir de l'information scientifique à partir d'une grande quantité d'objets et de textes présentés sur des étiquettes. En outre, il y a dans cette exposition des stratégies orientées vers le dialogue avec le public, comme la possibilité de manipuler des pièces anatomiques, des consignes favorisant la réalisation de :omparaisons entre les pièces et la possibilité de se guider à partir des couleurs ou d'autres éléments de décor.

Musée Océanographique

Le Musée Océanographique est une section de l'Institut océanographique de l'Université de Sâo Paulo. C'est le résultat d'un projet élaboré par des professeurs de cet institut. Il a été créé en 1896**.** Sa conception de départ a été élargie avec la construction d'un espace qui présente la collection du musée, y compris la « mostra viva », qui comporte des aquariums. En tout, il jouit d'un espace d'exposition d'environ 550 m^2. Il est situé dans le même mmeuble que l'Institut océanographique.

La collection du Musée Océanographique a été constituée à partir des recherches réalisées par les professeurs de l'institut et des instruments utilisés pour le prélèvement du matériel biologique. Elle contient aussi des objets, des photographies et de l'équipement provenant d'une expédition réalisée dans l'Antarctique en 1983**.** Les responsables ont conçu et monté l'exposition à partir de ce matériel et ils y ont ajouté des maquettes et des extes qu'ils ont eux-mêmes produits. Les objets de la collection constituent les principaux éléments d'organisation**,** et les textes, les supports et le mobilier mettent en évidence leur mportance avec la préoccupation de rendre les connaissances diffusées accessibles au public.

En plus de présenter l'Institut océanographique de l'USP, l'exposition du Musée Océanographique cherche à montrer ce qu'est l'océanographie. L'approche est disciplinaire et l'exposition est divisée en quatre modules: océanographie physique, océanographie géologique, océanographie chimique et océanographie biologique. Mais en plus de présenter l'océanographie comme thème central, mission du musée selon ses coordonnateurs, celui-ci vise également la formation d'une conscience environnementale chez e public visiteur et entend jouer le rôle de musée universitaire, c'est-à-dire de moyen d'élargir le rapport de l'université avec la société.

Dans l'espace d'exposition, les objets sont présentés sur des supports en brique suspendus au plafond ou posés par terre. Une grande partie de la collection se trouve dans un large espace recevant de la lumière naturelle par des fenêtres pratiquées dans les murs. Les aquariums, cependant, sont situés dans un environnement sombre et chacun possède son propre éclairage. Dans cette partie de l'exposition, il y a une rupture avec a présentation disciplinaire de l'océanographie; l'intention est de montrer différents environnements marins ainsi que les comportements des êtres vivants qui habitent les écosystèmes. En conséquence, il y a des aquariums relativement grands qui présentent ies éléments tels les coraux, et d'autres plus petits, qui n'offrent que des spécimens pour observation de leur comportement.

Le Musée Océanographique réalise aussi des expositions temporaires et itinérantes et il a développé un programme d'excursions offertes au public intitulé «Expédition écologique-I'école à la mer». Dans ce programme, l'équipe du musée accompagne des étudiants de cycle moyen à la base océanographique de l'institut, située sur la côte de Sâo Paulo, dans le out d'étudier l'écosystème marin et l'importance de la préservation des océans.

L'exposition du Musée Océanographique est majoritairement centrée sur la diffusion de l'information scientifique, qui est réalisée soit au moyen des objets présentés à partir de l'ordre propre à la discipline de référence, soit au moyen d'une grande quantité de textes. Le choix d'une organisation disciplinaire de l'océanographie signifie une communication centrée sur la logique scientifique.

Néanmoins, dans quelques parties de l'exposition, on a créé des espaces thématiques dans le but d'exploiter plus à fond des contenus disciplinaires. C'est le cas des espaces consacrés au

requin, à la pêche et aux aquariums, par exemple. Là, l'exposition abandonne la perspective disciplinaire et favorise une lecture distincte visant à approfondir d'autres aspects liés aux objets exposés et souvent plus proches de l'univers du visiteur. Dans ces lieux, les objets et les textes sont entourés d'images et de décors, ce qui aide à porter sur eux d'autres regards que le regard disciplinaire.

Station Science

La Station Science est un centre de sciences lié à l'Université de Sào Paulo. Elle est située dans un grand espace de 4600 m^2. Ce centre a été conçu pour être un musée. 11 comprend plusieurs expositions sur différents domaines des sciences: la physique, l'astronomie, les mathématiques et la biologie. Il inclut «Station Butantã», «Oiseaux urbains» et «Aquarium ». Ces expositions sont bien distinctes les unes des autres, mais, d'une certaine manière, elles partagent toutes l'esprit de la Station Science, c'est-à-dire qu'elles sont inspirées du même modèle, le *htmds on.* L'intention est de garder dans tout le musée la perspective de la participation et de l'interactivité si chère aux centres de sciences. Puisqu'il s'agit d'une présentation interactive, les ressources utilisées consistent presque totalement en des modèles, des dispositifs, ou des objets de diffusion encourageant l'interaction physique. Les trois expositions de ce musée sont décrites ci-dessous.

La Station Butantâ offre une exposition inspirée d'une autre présentée au Musée Biologique de l'Institut Butantâ sur le même sujet. Ici, la préoccupation environnementale est marquée et on a toujours cherché à encourager le dialogue avec le public, surtout par la structure des textes. Ceux-ci s'adressent aux enfants. La plupart ont été rédigés dans une langue simple et à la première personne du singulier. Les contenus abordés concernent les animaux venimeux, la taxonomie et des concepts biologiques/écologiques, tels ceux d'habitat, d'alimentation ou de distribution géographique.

Cette exposition comporte surtout des vitrines genre terrarium, semblables à des dioramas, où se trouvent des êtres vivants et un espace interactif comportant le mobilier nécessaire à la réalisation d'activités avec des petits groupes de visiteurs. Les vitrines, ou terrariums, possèdent des décors; les murs internes sont peints avec des représentations de l'habitat de l'animal. De plus, les vitrines permettent de voir les aliments et l'eau nécessaires à sa subsistance. Sur certains murs de l'espace d'exposition, il y a des peintures représentant un serpent, « personnage » qui communique avec le public par les textes.

La Station Butantã offre aussi une salle interactive où sont disposés des tables, des bancs et quelques gradins où s'assied le public; un meuble à tiroirs et un ordinateur avec-un hypertexte sur l'Institut Butantâ. Sur chaque tiroir du meuble, il y a une image et un titre annonçant le matériel gardé à l'intérieur: des animaux ou leurs parties conservées pour être manipulés par les visiteurs. Il y a aussi un grand écran dans cette salle et un lieu entourant un poste de télé/vidéo.

Oiseaux urbains est une exposition qui a été élaborée par des chercheurs de l'Institut biologique de l'Université de Sào Paulo. Son but est de présenter les oiseaux de la ville de Sâo Paulo au moyen d'un «exhibit»[4] qui facilite leur identification à partir de leur image ou des sons qu'ils émettent. En se servant d'un équipement multimédia, le public peut obtenir de l'information sur le thème proposé.

Les contenus abordés portent sur la biologie, l'écologie, le comportement, l'alimentation, l'habitat, la taille des oiseaux, les nids qu'ils construisent et leur identification ou leur classement d'après les sons qu'ils émettent. Il faut souligner l'exercice d'identification visuelle des oiseaux au moyen d'images exposées sur un panneau lumineux ayant la forme d'un grand oiseau. Les images de ce panneau s'éclairent quand le public actionne le système multimédia

4 Le terme «exhibit» a ici le sens que lui donne Dean (1994).

contrôlé par ordinateur. Une fois actionné, le système établit un rapport entre le nom courant de l'oiseau, son image - qui surgit sur le panneau - et le son qu'il émet.

Aquarium présente des organismes vivants de milieux d'eau douce ou d'eau salée, ainsi que des êtres conservés dans des récipients placés sur des étagères. Il offre aussi des panneaux illustrés de photos du Projet Mamirauá[5]. Les récipients contenant des êtres préservés sont transparents et présentés de manière à faciliter l'observation de leur structure.

Le but de cette institution est de présenter la thématique de l'environnement au moyen d'animaux vivants, ce qui facilite le contact du public avec eux. Les thèmes permettent de différencier les deux milieux d'eau douce et d'eau salée, ainsi que les diverses catégories d'êtres vivant de ces milieux: crustacés, mollusques, enidaircs et échinodermes.

Bref, même en possédant des caractéristiques distinctes, les stratégies des trois expositions étudiées à la Station Sciences se ressemblent en ce qu'elles visent avant tout le public en utilisant plusieurs stratégies de communication. Par ailleurs, on note que cette stratégie n'est pas constamment utilisée. La logique et le langage scientifique sont alors prédominants. C'est ce qui arrive, par exemple, dans le cas des Oiseaux urbains et d'Aquarium en ce qui concerne le contenu des textes des étiquettes.

Museu da Vida - Espaço Biodescoberta

L'exposition du Musée de la Vie - Espace Bio-découverte[6] porte sur la biologie et son histoire. Elle présente certains aspects de l'évolution de la recherche scientifique réalisée par la Fiocruz, une institution à laquelle le musée est attaché. Son concept est fortement marqué par l'histoire de la science, l'éducation et la diffusion scientifique. Cet espace est parsemé d'éléments liés à l'intégration des différentes perspectives des musées : historique, interactif, etc., et favorise des expériences esthétiques, émotionnelles et cognitives. Cette exposition comporte surtout des ensembles interactifs, des jeux, des hypertextes, etc. Mais on peut aussi y trouver des objets scientifiques ou naturels, tels des fossiles, des êtres conservés dans des bocaux et des instruments scientifiques d'époque.

L'importance de Fiocruz comme lieu de recherche dans le domaine de la santé a aussi influencé la proposition faite au public. La Casa de Oswaldo Cruz *«(...) devait [en effet] faire une exposition sur l'histoire des connaissances sur la santé et rendre cette exposition intéressante par son contenu ».*

La perspective éducative de ce musée met l'accent sur la liberté et l'autonomie du processus d'apprentissage du visiteur. Les contenus sont présentés dans des textes offerts sur de nombreux panneaux et il y a des locaux pour la réalisation d'expériences et d'observations. Ces locaux sont pourvus d'animateurs qui assurent une médiation favorisant les dimensions cognitives et ludiques de la visite.

La proposition pédagogique sur laquelle se fonde l'exposition met en relief l'importance de l'animateur en tant que médiateur entre la connaissance exposée et le public. Autre caractéristique de la proposition, l'idée de travailler sur des «thèmes transversaux», tels la biodiversité et la santé.

Quelques-uns des contenus présentés sont : la biodiversité, sa distribution géographique, l'évolution, la cellule (animale et végétale, la théorie cellulaire), la reproduction (asexuée et sexuée), les micro-organismes, les vecteurs de transmission des maladies, le classement, l'adaptation, les concepts liés à la biologie moléculaire et à la génétique (DNA /RNA, *hérédité,* c/onage, etc.), ainsi que certains aspects techniques de /'usage du microscope.

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5 L'Estacào Ecológica de Mamirauû est située dans l'État d'Amazonas.

6 Le Museu da vida a été inauguré en 1999 et appartient à la Casa de Oswaldo Cruz - FIOCRUZ. Il comporte plusieurs espaces d'exposition distribués sur le grand campus de l'institution. Dans notre recherche, nous n'avons étudié que l'Espaco Biodescoberta.

Le lieu où l'exposition a été implantée a aussi influencé sa conception. Il s'agit d'une ancienne écurie, classée patrimoine historique, qui a servi, pendant les premières années de la fondation Fiocruz, à la fabrication de vaccins. C'est un grand espace d'environ 800 m^2, dont l'architecture a fortement influencé la muséographie de l'exposition.

Les stratégies d'exposition, fortement influencées par l'orientation de celle-ci, ont été élaborées par une équipe assistée par des architectes, des techniciens du design, de la communication visuelle et des arts plastiques ayant pour but de favoriser la médiation entre les contenus et le public. Images, couleurs, formes, objets, espace, mise en page des panneaux, mobilier et modules ont été expressément conçus pour attirer l'attention du visiteur par leurs aspects esthétiques et didactiques, et pour établir la communication avec lui.

Éducation et communication dans les bio-expositions

L'étude des expositions analysées a permis d'identifier leurs fondements. Ce sont d'abord des connaissances scientifiques, en particulier de la biologie, mais aussi de la muséologie, de la communication et de l'éducation.

L'analyse de l'espace d'exposition a révélé le système de signes existant, c'est-à-dire l'ensemble créé par les objets, les textes, le mobilier, etc., dans un espace déterminé. Cet ensemble d'éléments compose le discours présenté par les expositions. Ce discours est déterminé par la proposition conceptuelle de chacune d'entre elles. Cette proposition oriente les choix de perspectives, de points de vue, d'objets, de contenus et de moyens de communication avec le public. Le budget, le type de gestion et l'histoire même de l'institution influencent également le choix des stratégies expositives.

En ce qui concerne l'éducation et la communication avec le public, cette analyse du système de signes des espaces étudiés révèle l'existence de deux grands groupes de stratégies expositives. Dans le premier, les stratégies reflètent presque directement le savoir scientifique d'un domaine spécifique de la biologie pendant une période historique déterminée. C'est ce que l'on observe, par exemple, dans les expositions du Musée de Zoologie et, à certains endroits, dans les expositions du Musée d'Anatomie Vétérinaire et du Musée Océanographique. Dans ces cas, la présentation est basée sur la systématique

biologique, la taxonomie des êtres vivants ou l'organisation disciplinaire des objets, c'est-à-dire sur la logique du discours scientifique. Ces expositions se caractérisent par la présence d'une grande quantité d'objets semblables, qui peuvent être des êtres vivants, des pièces anatomiques conservées, des objets scientifiques ou naturels. Dans ces expositions, les textes sont plutôt rares, et, en général, ils ont tendance à être synthétiques et à se limiter à fournir des renseignements sur la taxonomie, la distribution géographique et divers aspects de la biologie des êtres. Ils sont inspirés, comme le notait Jacobi (1998), des textes scientifiques.

Le second groupe de stratégies expositives se sert d'une grande variété de formes de médiation pour transmettre les informations au public. En général, ces expositions sont organisées à partir d'axes thématiques qui déterminent les objets ainsi que les contenus sélectionnés et organisés. Ici, on retrouve le Musée de la Vie - Espace Bio-découverte et les expositions de la Station Science. Toutefois, il est possible d'inclure dans ce groupe quelques stratégies utilisées au Musée d'Anatomie Vétérinaire et au Musée Océanographique.

Dans ce second groupe, les objets sont placés dans des contextes déterminés et utilisés avant tout pour illustrer un concept, une idée ou un phénomène. Us sont donc moins nombreux. De plus, les moyens de diffusion, tels les modèles, les panoplies interactives, les modules participatifs, les jeux ou les hypertextes sur ordinateur sont nombreux. Mais on ne remarque pas de véritable tendance en ce qui concerne la quantité des textes. Toutefois, ceux-ci livrent souvent de l'information allant au-delà de la taxonomie et de la biologie des animaux, ou abordent carrément d'autres aspects de la vie de ceux-ci. Ces textes sont proches des textes de diffusion scientifique (Jacobi, 1998; Leibruder, 2000) ou des textes muséologiques (Jacobi, 1998), ce qui les distingue des textes proprement scientifiques.

En conclusion, l'éducation et la communication dans les expositions des musées de sciences peuvent être réalisées directement, à travers le contenu et l'information scientifique et viser la

transmission de cette information, c'est-à-dire se centrer sur l'émetteur. Mais l'éducation et la communication peuvent également passer par le dialogue, la négociation du ou des sens entre l'exposition et le public, par l'interprétation que ce dernier élabore. En d'autres mots, elles peuvent viser le récepteur. Les expositions peuvent inclure les deux tendances et nous n'avons pas noté de cas où l'on se centrait uniquement sur l'information à transmettre ou sur la médiation et le récepteur. Néanmoins, la proposition conceptuelle, d'une certaine manière, définit l'accent mis sur les stratégies éducatives et communicationnelles de chaque exposition. Cette proposition peut privilégier l'information ou le public, ou encore, utiliser des formes où ces deux perspectives peuvent s'articuler en respectant la spécificité des musées, la logique du savoir scientifique, mais aussi, et fondamentalement, la possibilité de compréhension des différents publics qui visitent les musées.

Finalement, trouver un langage éducatif et communicatif qui respecte les spécificités d'un musée, celles du savoir présenté et les capacités du public, est l'un des grands défis auxquels font face les institutions actuelles. Il ne semble pas exister de solutions toutes faites pour l'élaboration des bio-expositions. Il faut chercher celles qui permettent la réalisation la plus complète du rôle éducatif des musées et l'utilisation optimale des compétences des éducateurs qui y travaillent.

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A Study of the Process of Museographic Transposition in Two Exhibitions at The MAST[1]

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Within non-formal educational contexts, museum is regarded as an important source of learning and as a contributor to the acquisition, amplification and refinement of the culture of a society. This long-lived institution has been reviewing its specific characteristics in order to better define the strategies for interaction with today's public. The present study, conducted at the Museu de Astronomia e Ciências Afins – MAST (Museum of Astronomy and Related Sciences) of the city of Rio de Janeiro, Brazil, was realized within this framework. This Brasilian institution is a museum of science and technology that deals with science as a reference knowledge, i.e. as a body of knowledge organized around certain theories, conceptual frameworks, categories and other principles that make investigation possible.

The literature in the area of non-formal education, at least in the fields of science and technology, identifies museums, certain parts of the mass media, computer networks and other cultural and leisure centers as the institutions that promote this type of education. In general, these places offer activities, organize different types of events (exhibitions, free courses, fairs, meetings, etc.) for an heterogeneous public, without distinction as to age or specialized background, with the aim of increasing and improving scientific culture and scientific literacy (Beetlestone, Johnson, Quin and White, 1998; Bradburne, 1998; Lucas, 1991; Shen, 1975).

In the specific case of the museum, the users are present on their own free will, except in the case of school children who are usually brought in by their teachers. Whatever the motivation to enter the museum, the non-formal education accomplished is basically determined by the desire of the individual, and by the environment that has been especially conceived to provide a stimulating and pleasurable experience to bring the visitor closer to the world of science and technology. So it is necessary to take into account the specific characteristics of the museum, which has as its core a special articulation of **place, object** and **time** (Van Praët and Poucet, 1993), this is especially illustrated by the exhibition, which is the main means of communication of the museum with the public.

Accordingly, this study aims at analyzing the transposition of scientific knowledge in two exhibitions held at the MAST, one called **Astronomic Cycles and Life on Earth,** and

1. This investigation is based on discussions held with C. Franco, a researcher at MAST. The investigation was partly founded by CNPq (National Council of Research) with grants for university students who worked as interns at MAST: A. Menezes de Andrade, A. Fernandes Costa, D. Marchiori, F. Lopes Luiz, L. Fabbio Gonçalves, M. da Silva Figueiredo and N. Lanzellotti.

the other **Seasons: the Earth in Motion**. It examines the processes of museographic transposition of the scientific concepts related to the phenomena of night and day, and seasons of the year. The analysis presents the stages of transposition in the exhibitions, showing the key points for the study of this process. More specifically, the study sought to answer the following questions: 1) What are the stages of museographic transposition? 2) How does the relation between the knowledge to be transmitted and the communications resources develop in the course of the museographic transposition?

In order to achieve this goal, the study registers how the concepts selected are treated in reference works, and how they are presented by means of museographic resources in exhibitions. Two proposals were compared: that of the designers and that of the exhibitions themselves. The persons responsible for the organization and elaboration of the exhibitions replied to a structured questionnaire consisting basically of questions related to the conception of the exhibition, its theme, its production strategies and resources, as well as the changes that occurred during the assembly process.

In addition, the study followed and interviewed family groups visiting the exhibitions (6 groups in each exhibition). These groups were selected at random and observed according to a checklist that focused on how the visitors used the exhibition, if they interacted with it, how they handled the devices, if they read the texts, if they established dialogues amongst themselves, etc. At a later stage, the groups observed were interviewed in regard to their understanding of the theme and the phenomena focused on in the exhibition. These interviews were recorded.

The execution of the study, which has a qualitative focus, is based mainly on a theoretical framework derived from two areas of knowledge: the first from the field of education, referring to the concept of didactic/museographic transposition; the second from museology, in respect of the production of exhibitions. We shall first examine the questions relating to the transposition of the reference knowledge to the knowledge exhibited, in order later to explore the subject of this research, which is museum exhibitions. This will be followed by an analysis of the data gathered during the research.

The Concept of Didactic and Museographic Transposition

Scientific knowledge is not taught or popularized in museums the same way as it is produced in universities and research centers. When offered in different social spaces, scientific knowledge undergoes a series of modifications.

Research, such as that of Cicillini (1997), recognizes the existence of different standards of production of knowledge, represented by the work of researchers, teachers, popularizers of science, as well as producers of textbooks. According to Cicillini, the variety of standards of production can be summarized in the following way:

- Production of original knowledge: occurs in universities and research institutes;
- Elaboration of texts by researchers: textbooks for higher education and scientific journals;
- Popular magazines: texts created for a wide range of publics;
- Popular media: radio, television, articles in daily newspapers;
- Textbooks for primary and secondary school levels created by specialized editors;
- Reorganization and systemization of knowledge transmitted by the teacher during the teaching/learning process, as a result of the educational context.

Several authors have analyzed the process of change in scientific knowledge. In the school environment, Forquin (1993, p.14) discusses the production of knowledge and states that the school culture is of a specific and selective nature. Therefore, it is inescapable that (...) *"all education, and especially all school-type education, always presumes a selection from within the culture and a re-elaboration of the contents of culture selected for transmission to the new generations*"*. The author points out that school education is not limited to this selection of cultural knowledge and materials, but it must ensure transmission and assimilation of the latter. This occurs because the ideas of the theorists cannot be communicated directly to the students, making necessary the creation and use of instruments of mediation. Thus, the field of education is the home to processes of selection – inclusion and exclusion – and to the insertion of mediating instruments that transmit a part of the culture.

Research in the field of education supports the idea that *"scholarly knowledge and scientific knowledge are distinct forms of knowledge and the scholarly disciplines have an epistemological and socio-historical constitution that is different from that of the scientific discipline*"* (Lopes, 2000, p.150). This approach renews, among other implications, the recognition of the existence of a "scholarly culture", since the school is considered to be a locus of production and creation of a specific and original kind of knowledge.

The concept of didactic transposition popularized by Chevallard (1991, p.17) presents the idea that the contents of a body of knowledge that are designated for teaching are true didactic creations, driven by the needs of teaching that undergo a series of adaptive transformations. According to Chevallard, *"knowledge-as-it-is-taught, the knowledge that is taught, is necessarily different from the knowledge-initially-designated-as-the-knowledge-to-be-taught, the knowledge that is supposed to be taught*"*.

Other authors have explored the concept of didactic transposition and have proposed some criticisms. From their perspective, evidence exists that other elements, in addition to the *savoir savant*, such as, for example, social practices, are references and influence the construction of scholarly knowledge (Astolfi and Develay, 1990; Caillot, 1996).

The question of the transposition of scientific knowledge to social spaces, different from the original one, is attracting increasing attention in the field of teaching and scientific popularization. In this way, we see that other researchers such as, for example, those who are studying museum exhibitions, have appropriated the concept of didactic transposition in recent years. Of particular importance in this regard is the work of Simonneaux and Jacobi (1997), which proposes the notion of museographic transposition to describe the process that a specific body of knowledge undergoes while being transposed for an exhibition.

Museums are spaces that differ from schools, and they possess their own culture. This statement is based on Geertz's (1989, p.15) anthropological concept of culture. Geertz presents the term from the semiotic point of view, understood as networks of signifiers, as well as their analysis. According to Geertz, culture should not be understood *"as an experimental science in search of laws, but as an interpretative science in search of meaning*"*.

Herrero (1998, p.151) proposes that the museum be considered as a house of scientific culture, since it *"encompasses factors such as the creation of scientific knowledge, its*

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* The asterisk indicates a personal translation.

academic and political context and the selection and ranking of scientific content by a community having a specific interpretative viewpoint, [constituting] the *museographic discourse**", through which scientific knowledge is transmitted.

In his examination of the main form of communication in museums, Davallon (1988) points out the challenges presented by the elaboration of scientific exhibitions, his underlying hypothesis being that, at that moment, there occurs a process of representation, of figuration that accompanies the passage from scientific discourse (the source) to the discourse of popularization (the target).

Davallon analyses the process of representation based on a semiotic interpretation of the *space* where the publication occurs, indicating that the passage from the "source-text" to the "target-text" should not be understood as a mere translation, but instead as a transformation. So the "source-text" and the "target-text" are different from each other, and in the process of representation of the first in the second, an object – the exhibition – is produced. In this context, the elements of the scientific text are the raw material of the process. Davallon, using the process of representation, analyzed the *space* in scientific and technical exhibitions, which may, from a neutral and instrumental perspective, be considered as a mere functional support for objects. However, from the communication and semiotic standpoints, *space* is an element that participates in the production of effects being considered in this case as a means of talking to the visitors, through works that produce sense.

In order to better understand the process of transformation of scientific knowledge into exhibited knowledge, the next section examines in detail the theoretical background of museum exhibitions.

The Exhibition: Unit of Study

The idea of the exhibition is the subject of some form of reception by an individual, whatever the type of object: works of art, ethnographic artefacts, scientific texts, machines or commercial products. Therefore, an exhibition shows something. However, it does not limit itself to showing something. It also indicates how this something should be seen. From this viewpoint, it can be approached as a means of communication, being characterized by the simultaneous presentation of content and of an interpretation technique, which proposes an understanding of the exhibits. In addition, it is important to perceive the exhibition as essentially an act of language.

> The grouping of objects in a space open to the public is not sufficient to render such objects comprehensible. In addition, one must provide a presentation and an environment that makes sense. To the contrary, the capacity to make sense is not directly proportional to the volume of text presented in panels, posters, catalogs, etc. Meaning also derives from the arrangement, the setting of the scene, the use of diagrams, photographs and other visual or spatial mean* (Davallon, 1999, p. 87).

No single operational form for the production of every type of exhibition exists. There is also no exclusive form for specific themes, although there are ways of exhibiting with characteristics that are, to a greater or lesser extent, suitable for a particular type of exhibition. Thus, uses, strategies and effects of an exhibition of a historical nature are not the same as those produced by an art exhibition or by an exhibition of documents.

The analysis of the functioning of exhibitions leads one to see that the act of exhibiting goes beyond merely making objects public. For this reason, for example, art exhibitions use text in a totally different way from that observed in exhibitions with scientific and social themes. This shows that exhibitions have different natures (aesthetic, semiotic, sociological, etc.). Therefore, all exhibitions can, to differing degrees, produce significant and instrumental aesthetic results, without being merely works of art, semiotic texts or didactic instruments.

Above all, exhibitions are products obtained through the use of a technique. In this sense, they correspond to an intention, in other words, to an objective of producing an effect. The question is: what is the intended goal or what is the function performed by the exhibition? According to Davallon (1999, p. 10), it is important to be precise as to what is understood by intention (declared intention – specific project of an author or of an exhibition), as well as to raise the question of what do exhibitions consist of as independent cultural productions.

With regard to the constitutive dimension, the exhibition must not be viewed as a constituted cultural object, but as the result of its own execution process. From this standpoint, the objective is to understand the process from which the exhibition derives, in other words, the set of technical operations, the space and the social actors involved. The production works at two levels of intention: the first corresponds to what could be called constitutive intentionality (the intention of the elements present in the execution process – technical strategies); the other being the communicational intentionality (intention related to the desire to communicate with the visitor in a certain way – communications strategies). An exhibition can thus be broadly defined as a contrivance resulting from the arrangement of things (historical objects, 3D devices, dioramas, videos, slides, computer equipment, showcases...) in a space, with constitutive and communicational intentions, and capable of attracting the public.

The concept of an exhibition based on the above-mentioned points emphasizes above all the operational dimension, inextricably linked to the semiotic dimension (the form of presentation which always suggests meanings). The focus of an exhibition is its language and its meaning. However, one must note that it exists outside the fields of linguistics and imagery, to the extent that it works mainly with objects and space. Its production is also linked to the patterns of participation of the visitors, thereby inserting itself in a field of complex relations, in such a way that the exhibition becomes a product that encompasses semiotic, pedagogical, aesthetic, scientific and other elements. Within this context, the exhibition can be characterized by the heterogeneity of its components.

In order to determine what is essential in an exhibition, this study took as reference the conception of Eco (1985, cited by Davallon, 1999, p. 14), in which the text is seen as a communicative entity, "*a mechanism that demands sensing by the receiver in an interpretative process**". Bearing in mind that there may be a discrepancy in competence between the sender and the receiver, "*the type of (text) interpretation must be a part of its own generative process, to generate a text means to execute a strategy that includes forecasts of the movement of the other**". Therefore, the text must have a margin of predictability with regard to the competence of the future receiver.

Based on these statements, one can understand the exhibition as a text endowed with an intention. Eco (1993) argues that, even if we use unlimited semiotics (enabling multiple meanings of reading), there exist criteria and *modus* (limits, frontiers) that circumscribe

interpretability. In order to delineate these criteria, he emphasizes that between the intention of the author (*intentio autoris*) and the intention of the reader (*intentio lectoris*) there exists a third possibility: the intention of the text (*intentio operis*). All that matters is to know what the text says. Thus, a visitor (*reader*) while interacting with the exhibition-text is not going to grasp the intent of the designer, but the intention of the text. According to Eco (1993, p. 75): "*in the same way as the intention of the text is basically to produce a model-reader capable of making suppositions about itself, the initiative of the model-reader consists in imagining a model-author that is not empirical and that ultimately coincides with the intention of the text**". By introducing the contrast between the intention of the reader and the intention of the text, Eco dilutes the intention of the empirical author. Therefore, the interaction between the intention of the text and the intention of the reader defines the margins of interpretability, which means that, although the text may be open to innumerable forms of interpretation, the reader is not free to interpret idiosyncratically.

The Exhibition: from Knowledge to the Visit

In order to understand the transformation of the reference knowledge based on the semiotic functioning of the exhibition, the simplest way is to follow this transformation up to the time of the visit. The present study assumes that exhibition is a language. In general, we can distinguish three logics of language in the production of an exhibition. These are: *the logics of discourse, space and gesture*. There are also three moments of transformation: preparation, execution and visit to the exhibition. Each moment does not use just one logic of language. Our interest lies not in talking about each moment separately, but in grasping the frontiers of the passage from one logic to another (Davallon, 1999).

The first moment corresponds to the frontier between a certain knowledge and the strategy to put it on exhibition (exhibition procedures), in other words, the passage from the logic of *discourse* to that of *space*. This passage is the act of installation of knowledge in space – the act of creation of the exhibition as a cultural object, which, in certain cases, can occur while the exhibition is designed. In other cases, this may occur when the exhibition is being executed by the design team and the executants, within the space itself. The second moment is marked by the arrival of the visitor. For the latter, understanding the exhibition is subordinated to an activity and a logic of the gesture (path, approximation, observation, etc.).

These views are simple analytical models and permit the description of trends that must be adapted to each case. These vary according to the body of knowledge, the type and size of the exhibition, the institutional structure of the production, etc. The dynamics of the transformation operations from the knowledge of reference are characterized by the treatment of the scientific discourse of scientists, the knowledge to be exhibited and its location in space by architects, designers and makers. This organization can have a strong and distinctive influence on the final product. Below are presented each of the logics active in the stages of production of an exhibition.

The "Logic of Discourse"

The "logic of discourse" is related to the operations of language that involve aspects of production of the textual structure. Two operations are present: 1) The definition of the idea of the exhibition, the underlying objectives and their insertion in the institution's

program. This discourse can often be found paraphrased or reproduced in parts of the exhibition or in its catalog; 2) The scientific text, which originally constituted the content and theme of the exhibition, and that undergoes, during rewriting, many operations of selection, exclusion and comparison.

The identification of the objectives of the exhibition and the rewriting of the scientific discourse, through the drafting of a program, initiates what will become the exhibition, defining a strategy that will establish a style. The semiotic effect of these two operations is to extract a body of knowledge from the scientific field and reduce it to a content from the viewpoint of the exhibition program.

The "Logic of Space"

The "logic of space" can be characterized according to the various language operations to which it is related: those concerning *conception* and *execution*. This division is based on logical and chronological criteria, though this does not mean that these two operations are, in practice, totally separate.

With regard to conception, two types of operation can be distinguished: conceptualization and *mise en scène*. The first refers to the elaboration of the concept of the exhibition, in other words, the concept of the product and, eventually, the concept of communication. *Mise en scène* corresponds to the division of the exhibition into various sequences that link the theme and that precede the visit. These operations are organized so as to provide meaning to the elements exhibited.

Concerning the operations related to execution, one finds that the different ways in which to put on exhibitions are related both to the type of knowledge displayed and the size or genre of the planned exhibition. For example, exhibitions dealing with themes attractive to scientists have become secondary because of the gap between disciplines caused, to a certain extent, by media-related impositions, as well as by technical characteristics, costs and/or simply the pressure of certain fashionable styles or techniques of exhibition. In such cases, the concept of the exhibition tends to ignore the logic of scientific discourse in favor of a visual and spatial logic. Spatial language seems increasingly to fuse conception with execution at a specific moment: that of production.

These diverse operations have the semiotic effect of providing support to the figurative and narrative treatments of the knowledge that serves as the exhibition's content. This is a process of symbolization, since the meanings attributed by visitors to the exhibition are not available *a priori*, but depend on the context constituted by the exhibition as a whole.

The "Logic of the Gesture"

This logic is characterized by the mobilization of the visitor's behavior, the interaction of his or her knowledge with the finished exhibition. Within the logic of the gesture, two types of semiotic operations are present: time and reading. Time corresponds to the duration of the visit, during which the visitor comes into contact with the form and elements presented. In contrast, reading or interpretation is the sequence by which the visitor reads and recognizes texts, objects and images. In addition, it conforms to and uses the organizational structure of the exhibition, created according to spatial and symbolic aspects. For the visitor, these operations function as marks of intentionality and of

reconstruction of the content of the exhibition, facilitating the (re)signification of the data he or she carries or acquires.

This individual reading, supposedly spontaneous and undirected, in reality is shaped and guided by operations pertaining to the logic of discourse and the logic of space, from the drafting of the exhibition program to its symbolization, the process to which the original scientific knowledge was submitted.

Organization of Data

Reference Knowledge

Both exhibitions examined in this research dealt with the cycles of the seasons of the year and of day and night. As a first step, we sought to identify how this content was presented in the textbooks of reference knowledge. These seasons and days cycles have a historical and social importance that has attracted the attention of researchers in many areas of knowledge. Therefore, we conducted a search of the reference knowledge of astronomy, as well as of related areas, such as geography and biology.

In the field of astronomy, we examined popular university-level textbooks that are read by future astronomers. Since textbooks are used, a didactic transposition is implicit. The topics chosen (seasons, and day and night) are found in the chapter dedicated to the construction of the time equation, which implies measuring up the classical notion of time and taking into account corrections due to the Earth's movements. In order to achieve this goal, certain concepts are introduced, including: sidereal day, solar day, vernal equinox, points of equinox and solstice, ecliptic, tilted axis of the Earth, apparent movement, latitude and longitude. In the textbooks of different fields, one strategy for the construction of an explanatory model is to consider some basic assumptions that enable, – in addition to simplifying the mathematics, – the introduction of newcomers to the form of knowledge production in a particular field.

From the standpoint of astrometry, the Earth is a rigid and homogenous body without an atmosphere, therefore capable of being substituted by any cosmic body with similar physical characteristics. In addition, the Sun is considered to be a source of parallel rays, although this is not made explicit in the model. In this form, the concepts of the seasons of the year and of day and night are not used from a historical or social viewpoint, but for the mathematicization of the notion of time, without discussion of the notion of light and dark.

In biology, the references were works used for the popularization of science in the field of chronobiology (biological rhythms), since this topic encompasses the relation between the selected concepts (seasons and day and night) and life on Earth. In the study of biological rhythms, organisms are considered to be organized in time and space and having, during the process of evolution, adapted, by means of anatomical and biochemical modifications, to the temporal dimension of the environment, i.e. not only to space. Thus, animals possess internal oscillators called time markers that are synchronized with certain environmental cycles – the seasons of the year and day and night. For biologists, the most important point is the notion of periodicity implicit in these concepts because it helps them to structure their knowledge about biological rhythms.

The sources consulted to characterize the body of knowledge in geography were textbooks used by the future professionals of the area. In geography, the cycles of the seasons of the year and days and nights are included in the concept of time. However, the

mathematicization that is so characteristic of astronomy is absent. The concepts involved are: celestial sphere, points of solstice and equinox, ecliptic, vernal equinox, latitude and longitude. The measurement of time, from the standpoint of geographers, is related to the construction of concepts that are characteristic of this field of knowledge, such as legal hour, legal time and time zones. Therefore, it is closer to a civil view of time, in other words, the result of the social need to organize hours in accordance with longitude.

Intention of the Exhibition: Astronomic Cycles and Life on Earth

Conceptual proposal

The design of the exhibition, in the mind of its designers, had as an objective to present the relation between astronomic phenomena and life on Earth from a multidisciplinary perspective, in such a way as to encourage an understanding of nature. For this purpose, a few biological phenomena were chosen, those linked to certain astronomic phenomena familiar to the visitors. These were: a seawater aquarium; the behavior of bees in a hive and the relation between its position and the Sun; biological rhythms and the influence of day and night and the seasons of the year on animals; the incidence of light and heat on Earth determining the occurrence of phenomena such as photosynthesis, breathing of living beings, functioning of the gas and energy cycles. In relation to the existence of Earth's atmosphere were showed some phenomena such as rainbow and why the sky is blue. In contrast, were showed the eclipse of the sun from the moon and a chronology of the space rockets.

> The general theme of the exhibition is the relation between basic astronomic phenomena and life on Earth, and in addition, atmospheric and astronautical phenomena. The sequence was: Earth-Atmosphere-Cosmos. The idea was to hold an exhibition in which the conceptual and fragmented character of the previous show – Science Laboratory – would be discarded in favor of an interdisciplinary approach. We thought the theme lent itself to this type of approach*. (designer)

In order to present these phenomena, several strategies were used that sought to link scientific information with interactive elements that would stimulate a direct and dynamic relation with the content on view. These were: images, texts, objects from the museum's collection; living dioramas; interactive devices... with a preponderance in the design of basic colors that, according to the ideas of Mondrian, acquired functions, as exemplified by the discourse of the person responsible for visual programming:

> In visual terms, I worked with five colors. The predominance of white serves to provide an idea of amplitude; black plays an aesthetic role, which is the representation of the X,Y and Z axes..., cyan blue which, apart from an aesthetic role, serves to display the text about the functioning of the modules; yellow (...) serves to support the scientific text and, finally, red has a purely aesthetic function. (...) the main concept was interaction between children and the exhibition; therefore I considered it necessary to resort to the use of primary colors (...)*". (designer)

The elaboration of the interactive devices took into account the level of interaction and the intrinsic characteristics of the phenomena under scrutiny, as well as the possibility of an interactive approach to biological phenomena. A hive was built to enable liv

observation of different types of bees; an aquarium displayed marine animals; spin-light panels showed the carbon and oxygen cycles in the environment. There were also panels with texts and diagrams about these themes. This exhibition also included other devices based on related astronomic and physical phenomena (incidence and dispersion of light, thrust, seasons of the year, etc.). Thus, the exhibition can be seen as phenomenological, as it concentrates on phenomena, in whole or in part.

Twists and turns

During the process of elaboration of the exhibition, moments of agreement and disagreement occurred among the members of the team. They agreed on the proposal of an exhibition focused on basic questions of astronomy and their relation to life. However, areas of disagreement occurred that interfered and determined how some phenomena were approached. The use of texts as the museographic resource used to link the phenomena – an element highly characteristic of the exhibition – was a source of conflict among the members of the team.

> Texts in the first place, then images, interactive devices, live dioramas, items from the collection, showcases with space vehicles and shuttle*. (designer)
>
> (...) In my view, there shouldn't be a lot of text or concepts or explanations. I wanted to show that knowledge of the universe is good for mankind*. (another designer)

Some content was made available during the didactic transposition to meet the requirements of one of the designers using a relation of authority based on hierarchical positions occupied by group members within the institution. This relation was made explicit in the division made within the group between thinkers and doers.

> In my view (and today), it is currently impossible to work while being in a head position. The competition and the confrontation are too great*. (designer – the thinker)
>
> (...) I was asked to build a pre-defined experiment to merge images*. (designer – the doer)

For this reason, the theme of the exhibition is presented by the juxtaposition of museographic resources, losing the identity originally proposed of presenting the relations in an organic and integrated manner.

In the case of this exhibition, the cycles of the seasons of the year and of day and night are not the focus of the didactic transposition, since the approach to the theme is centered on the exercise of establishing relations between various astronomic and physical phenomena with life, trying to understand that the biological cycles of living beings are intimately linked to the environment and the changes therein. According to the concept of the exhibition, Earth is considered a cosmic body that possesses certain characteristics, such as the presence of an atmosphere and location in the solar system, that enable the existence of life in its varied forms and expressions.

Thus, the concepts are presented on the periphery by means of interactive devices based on astrometrical models (for example: quasi-circular orbit, Sun as a source of parallel rays, Earth as a rigid and homogenous body) and show the periodicity of such phenomena, characterizing them as time markers. This is the main structuring element in the didactic transposition performed in this exhibition, mobilizing the elaboration of a relation between

the phenomena and life. So, any explanatory model carried in by the visitor containing this element, even if incompatible with scientific knowledge, is useful in reaching the proposed objective. It is worth noting that the strategies used in the didactic transposition could not, by themselves, provide sufficient elements for the visitors to build their own explanatory models regarding the cycles, since this was not the main objective of the exhibition.

Intention of the Exhibition: The Seasons of the Year: The Earth in Motion

Conceptual proposal

According to its designers, the idea of this exhibition arose from the evaluation of the Astronomic Cycles and Life on Earth exhibition and from requests originating from schools that generally did not correctly treat the cycles of the seasons of the year and day and night.

> The choice of the theme was based on two factors: 1) The realization that, while usually a subject of study in schools, this is often treated erroneously by teachers, since they often subscribe to alternative models; 2) The evaluation of the Cycles exhibition [referring to the Astronomic Cycles and Life on Earth exhibition] showed that an exhibition centered on a single theme had a better chance of being understood by the public*. (designer)

Based on this viewpoint, interactive devices were built in such a way as to show the importance of the tilt in the Earth's axis as a basis for the causal explanation of the phenomena of the seasons of the year and day and night, and to combat the idea put forward in school environments that the distance from the Earth to the Sun plays a major role in our understanding of these phenomena.

The exhibition was composed of interactive devices that present the constituent elements of the concepts involved, assisting in the construction of explanatory models, above all in the understanding of causal mechanisms. Thus, one device, for example, relates the warming of a surface with its slope, another shows the difference in the quantity of light rays reaching the Earth's hemispheres when its axis is in the vertical position or tilted in relation to the plane of its orbit; yet another proposes the exercise of moving the Earth around the Sun at the correct inclination. The devices complemented one another. In addition, two synthesis models were used to try to simulate the cycles of day and night and the seasons of the year.

> The strategy was to identify the main elements of a model for the teaching of such phenomena and create devices that covered these elements in isolation or in part, and synthesis devices in which all the elements of the teaching model would be present. The devices ranged from purely contemplative ones to others with varying degrees of interactivity*. (designer)

In this exhibition, aspects related to culture were explored by means of graphic resources, such as panels depicting Monet paintings and the projection of slides showing social activities of the different seasons of the year on both hemispheres of Earth. Each model bore a written indication of how it should be used, accompanied by provocative questions about the constituent elements of the phenomenon presented. Texts with

explanations and theoretical details were placed in appropriate locations easily accessible to the visitor, in case he or she wanted to obtain such information.

Twists and turns

During the process of elaboration of the exhibition, the team shared, from the beginning, some assumptions which would guide not only the museographic conception, but also the establishment of more homogenous work relations. Tasks were distributed according to the individuals' professional backgrounds and not according to hierarchical status.

The main points of consensus in the team: the educational viewpoint that guided the construction of the devices and the elements should be included, plus the decision to emphasize the interactive nature of the exhibition. This resulted in the use of text only in the instructions for operating of the devices and, in the inclusion of social aspects related to the cycle of the seasons of the year, by means of visual resources (panels and slides).

Debates within the group were structured so as to reach agreement with regard to the form by which the constituent elements of each device would be presented.

> I suggested we should show that the Earth has other movements in addition to rotation and celestial motion. To show this, we considered using spinning tops to enable analogies with precession and nutation. This generated the idea of making a model to represent precession. It ended up being rejected because of the scale of time. Indeed, the model would have given the impression that a cycle lasting 26,000 years took only one year. This would have caused problems for the celestial motion model with tilted axis*. (designer)

The above position shows that, despite disagreement over the inclusion of precession as one of the constituent elements of the model explaining the seasons of the year and day and night, the decision was taken not to include this topic in favor of maintaining the initially established assumptions.

In the present exhibition, the didactic/museographic transposition of the cycles of day and night and the seasons of the year was based on the strategy of presenting on several devices the constituent elements of the explanatory model. The question of the tilt in the Earth's axis, as the cause of the phenomena, was given the main emphasis. The educational paradigm steered the didactic transposition using as main reference questions related to learning, in other words, to cognition.

The exhibition was conceived for the visitors to interact with the models, to think about their ideas concerning the phenomena, to call into question their mental models and to help elaborate models that are closer to the current consensual one (body of scientific reference knowledge).

The Visitors and the Exhibition *Astronomic Cycles and Life on Earth*

Decoding the intention of the text

From the analysis made by the visitors of this exhibition, it is clear that, due to the large number of topics/phenomena on show, they tended to emphasize the subjects closest to their life experiences. Such is the case of a 14-year old boy who showed much interest in the aeronautics section because he intended to enter the military career.

In general, visitors did not grasp the overall theme of the exhibition; they were not able to establish a relation between the museographic devices/resources presented. They commented on the concepts related to each of the devices in an isolated way, thus building a fragmented *text*.

> "There's some interesting stuff, but we didn't see this correlation in regard to the seasons and days and nights*". (father of family group)
>
> Interviewer: The Magdeburg hemispheres...After that, what did you see?
>
> Man: "The rainbow and the eclipse".
>
> Interviewer: "The eclipse is in the third place and then what?"
>
> Man: "Bees...We couldn't find the queen*".

Another form of reading is the establishment of relations that are different from those proposed by the designers. However, these relations were not made among devices, but with themes related to those presented by the devices. This is the case of one visitor who emphasized the bees as an example of social organization, and talked about the water cycle in relation to environmental issues and how man can interfere in this cycle and in the oxygen and carbon gas cycles.

The visitors identified the role of the texts used as sources of explanations of the phenomena on show, but did not use them to establish links between devices.

> (The texts) in this room are much better than in the rest (of the museum), much better produced...Technical information is available to answer one's questions*. (mother of a family group)

Although many visitors made no connection between the concepts presented and life on our planet, a small number of them went so far as to say that the exhibition examines the existence of life as a function of the presence of the Sun.

> It shows life. For example, without the Sun, there would be no life. We depend on celestial bodies, especially the Sun, for life. Without it, there would be no light or life. The water cycle is also important, as I read in there [the exhibition]. It shows microscopic life on the ocean floor, it shows everything about life on land and at the bottom of the sea*. (father of a family group)

One interesting aspect is that some of the interviewees mentioned the showcase demonstrating the development of space vehicles as one of the points that most attracted attention, although they did not relate this to the existence of Earth's atmosphere. In contrast, the designers did not emphasize this subject during conception although it did occupy a significant space in the exhibition.

The role of the museum and the exhibition as a whole

The content of the interviews reveals that the visitors consider the museum as a complement to school activity in regard to the presentation of scientific matters, and that this has a high value in the science museum. In addition, they see the use of the resources available in the exhibition, such as, for example, the three-dimensional objects and the

interactive devices reproducing experiments that are familiar to many only through the oral description of a teacher or in a book, as a novel experience.

> Boy: "I liked the eclipse and the space vehicles".
>
> Girl: "The tube that when one talks it takes a long time to hear".
>
> Interviewer: "What do you think those things you saw were doing together?"
>
> Girl: "It's science, what we learn in school."
>
> Mother: "In the past, students only saw experiments in books; they couldn't experiment to find things out.Today, this is possible. I don't think it [the museum] receives enough publicity*".

In the exhibition, visitors emphasized the importance of the theme discussed as an opportunity to acquire culture and the fact that the exhibition showed aspects of technological progress, especially the conquest of space.

> Boy 1: "I think the showcase with the rockets shows the conquest of space and how man developed rockets.*"
>
> Boy 2: "All the things on display are supposed to bring culture to people*".

The Visitor and the Exhibition *Seasons: the Earth in Motion*

Decoding the intention of the text

Analysis of the interviews shows that the majority of the public understood both the general theme of the exhibition – the seasons of the year and day and night – and the strategy used by the designers to make available, by means of interactive devices, the constituent elements of the phenomena. The visitors also perceived the idea of the complementarity of the devices:

> In order to see this one (a reference to the model of the Sun), I had to pass by this one over here (a reference to the model of the tilted axis)*. (child of a family group)
>
> There's one where there is a ball of light representing the Sun and the Earth at a certain distance. As you move the Earth, you are performing the Earth's celestial motion in relation to the Sun. And then there's the one where the person wears a helmet with a light. Then, you become the sun in relation to the Earth. You press the button and the Earth starts to spin. Then it shows the movement of the Earth's rotation and how the Sun works during the rotation movement...how the Sun illuminates the Earth during the rotation movement*. (teenager who visited the exhibition with his brother)

But, while some identified the theme of the exhibition, others, as a result of their own life experience, were able to view the intention of the exhibition on a deeper and more detailed level, identifying the axis of didactic transposition and grasping the aims of the designers. Such is the case of a young physics teacher who understood that the aim of the exhibition was of combating the idea, popularized in many school environments, that the distance between Earth and Sun is the cause of the seasons of the year:

Conclusion

Returning to Davallon's (1999) categories regarding the three logics of language in an exhibition, the logic of discourse, the logic of space and the logic of gesture, one can see these logics interacting in different ways in each of the exhibitions, expressing different processes of museographic transposition.

In the case of the *Astronomic Cycles and Life on Earth* exhibition, the focus of the logic of discourse is the **relation** between the basic astronomic phenomena and life on Earth. From this standpoint, the museographic resources used to operationalize the *mise en scène* – belonging to the logic of space – were not, at the end of the museographic transposition process, in tune with the logic of discourse. In other words, the *mise en scène* did not emphasize the **relation**, thereby failing to provide marks of intention that could help the interpretation of the exhibition-text in accordance with the proposed approach.

The way in which these logics were put in operation shaped the logic of the gesture, which is based to a greater extent on the knowledge of the visitors. Their interaction with the exhibition was determined not by the re-signification of the data collected but, instead, by the recognition of such data.

In respect of the *Seasons: the Earth in Motion* exhibition, the focus of the logic of discourse is on the presentation of the constituent elements for building a model explaining the cycles of the seasons of the year and day and night. Among these constituent elements, special attention is paid to the importance of the tilt of the Earth's axis as a basis for the causal mechanisms of the phenomena presented. This is the vector of museographic transposition.

It can be seen that the museographic resources (interactive devices, slides, panels) used in the elaboration of the *mise en scène* were compatible with the logic of discourse selected for the exhibition.

As a result, it was noticeable that the visitors interacted with the exhibition by recognizing the marks of intent, re-signifying the data collected during the visit in light of previous knowledge.

It is important to acknowledge the different ways involved in the process of the museographic transposition in the two exhibitions. The second exhibition deals with the content of knowledge in one area of learning, while the first handles a cognitive category – **the relation**. The latter implies a more sophisticated and arduous work.

The analysis of the exhibitions demonstrates that the interpretations made by visitors are determined by the intersection between the intention of the exhibition-text and the intention of the visitor-reader. This result confirms that this interaction defines the margins of interpretability, that is, despite the exhibition-text having a wide range of possible interpretations, the visitor is not free to interpret whatever he or she wishes. If the museographic transcription does not take into account these aspects, the reading of the intentions of the exhibition will suffer.

Therefore, the understanding of the process of museographic transposition implies the identification of the relevant marks of intention that should be present in the exhibition and, in addition, the understanding of the context in which this process occurs (the body of knowledge, the institution, the equipment and the visitors). The relational situation created allows the visitor to attribute meaning to the exhibition. This is the challenge faced by museums.

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Museum-School Relationship and the Broadening of Scientific Culture

S. Cazelli, G. Gouvêa, M.E. Valente, M. Marandino, C. Franco

Introduction

Numerous papers on the issue of scientific literacy in society – and its low levels – can be found in specific literature (Lucas, 1983; Miller, 1983; Prewitt, 1983; Shen, 1975; Ucho, 1985). The need of an informed society capable of finding immediate solutions for basic problems became vital, as well as a proper understanding of governmental policies involving science and technology, knowing how to participate via legitimate democratic channels. An informed society became vital also to understand the world as it changes.

Within this context, museums of science and technology are chosen as important sources of learning, and also for their contribution in raising the level of scientific literacy in society; scientific education and the expansion of cultural perspectives are not restricted to school spaces.

It should be noted that such museums are not – in any way – scientific and technological research institutes in the usual sense of the term. Neither can they be mistaken for laboratories and other institutions whose aim is scientific discovery and knowledge development in the field of natural sciences. Their main commitment to investigation is linked to pedagogical and museological issues related to a correct and intelligible propagation of sciences and technologies for people of various ages and diverse educational levels.

Museums of science and technology are not the only non-formal spaces where people can acquire scientific information: cultural centres and the media in general can offer it too. If these various institutions do contribute to scientific literacy and to expand cultural perspectives, it seems relevant to inquire how this is done and the exact contribution of each, but to do so, one must examine their particularities. Besides this, one must explain the concept of culture which is adopted.

The concept of culture which guides the research activities of the Education Department of the Museu de Astronomia e Ciências Afins – Mast[1] is the one advocated by Geertz (1978). To him, this concept is essentially a semiotic one, a system of signs: culture seen as "webs of signification" created by man and "not an experimental science in their quest for laws, but an interpretative one, in search of signification". It is through the symbolic action of human behaviour that we come to a design of what culture is. Behaviour can be seen as

1. Museu de Astronomia e Ciências Afins – Mast, situated in Rio de Janeiro (Brasil), is a museum of science and technology that has been struggling to find a harmonious association between the historical dimension and the didactic and interactive aspects of its exhibitions.

social discourse – a mixture of signs, symbolic actions that convey information about a given culture. Culture would then be a set of plans and programs, propositions that drive humans to act and think in a given fashion. Scientific activity being a social practice, it generates a system of symbolic signification that is culture. Scientific activity thus spawns signification that composes scientific culture.

The present study focuses on how the particularity of the science and technology museum institution is understood, on its relationship with the processes of expansion of scientific culture, and on how these two aspects are made explicit in the pedagogical practice carried out by basic level teachers during their visit to Museu de Astronomia e Ciências Afins – Mast.

The study

At present, the educational department at Mast is working on the issues of an education in science practiced by the museums, taking into consideration the learning aspects and the museum-school relationship.

The Problem

Results from an investigation entitled: "Interaction and Shared Learning Patterns in the Exhibition Astronomy Laboratory", held by Mast in 1995/96, showed that teachers considered the visit to the museum extremely profitable for diverse reasons such as: "It complements school, contributing for a better sedimentation of experienced contents"; "A motivation for the subsequent approach of various programmatic contents"; "It makes up for the scarcity of didactic and laboratorial resources at school"; "It provides relations between theory and practice". This way of understanding the meaning of a museum by the teachers characterised a school-oriented view of it. The museum was never regarded as a space for the broadening of culture in general, or of scientific culture in particular.

Researchers working on the museum educational experience have detected that their social role has lost its significance (Gouvêa, 1997; Hofstein and Rosenfeld, 1996; Lopes, 1991; Ramey-Gassert *et al.*, 1994). In order to salvage this aspect, not only as a space that contributes to the improvement of scientific culture, but also as a space that must not be considered definitive in the learning process, but a mediating one, the educational department at Mast developed a project called: "Continual Formation of Science Teachers and Non-Formal Educational Spaces", aiming primarily at rendering teachers capable of using the museum by focusing on its particularities.

Such a choice owes to the fact that, in order to deconstruct the pedagogical attitude of teachers when using the museum, more than a simple preparation a few hours prior to the visit is needed. This requires the understanding of 'backstage' museum procedures, a different pedagogy from the one used at school, and the notion that it is another way to mediate learning, for museums are communication media where one can see, touch, walk by, feel emotion and other impacts, all this implying freedom of choice, being at ease and uncommitted to any constraint or obligation.

The Course

In an attempt to get closer to the above mentioned purpose, a 48-hour course was held at Mast for teachers integrating the project, the latter all belonging to the official public educational network. The central axis in this course was the intensive exploration of the particularities of the museum institution. Initially, to deal with this question, each teacher's concept of museum was collected, and a debate followed. Then, we dealt with the history of the institution in the context of its availability to the public, that is, how the process of opening the great collections to public viewing took place.

Regarding science and technology museums and their history, we studied the evolution and the groundwork, pointing out the main changes in the museological, educational and scientific fields that contributed to the construction of the concept of what we understand today as a science and technology museum. To exemplify these points, Mast's permanent exhibition which is presented from a social-historical perspective of science, was visited.

Complementing such questions discussed in theory, a workshop followed – "Learning with Objects" – the purpose of which being to explore the potentialities of the museum item in order to develop skills, to expand knowledge and to build concepts.

Next, topics associated to basic astronomical phenomena and their relation to life on Earth were explored by visiting the interactive permanent exhibits at Mast (day/night and seasons' cycles, phases of the moon and eclipses). In order to better explain the subject "seasons of year", some pertinent knowledge was conveyed, such as how the sunlight arrives at the Earth, that is, the interaction of light with matter (generation, reflection, refraction, diffraction, polarisation, etc.).

The Final stage of the course included the presentation of the teachers' concepts about the museum-school relationship, followed by their discussion. Within this discussion different approaches and trends in science teaching were presented.

Methodology

In order to study how participating teachers appropriated the elements that constitute the museum specificity, and how they incorporated these elements into their pedagogical practice during their visit to Mast, we opted for a qualitative approach of the research.

The universe studied was that of 73 teachers characterised as shown in the attached tables (I, II, III). For data collection, two instruments were adopted: the observation of teachers during the visit with their students to Mast (17 observations), and a questionnaire (41 turned in) with open questions concerning the visit to Mast (including planning, comments made by students and teachers, repercussion at school, and their understanding of museum-school relationship) which was filled out at the project's closure. The guidelines for observations made during the visit presented three aspects: the first was related to the planning of the visit, the second to the organization of the students by the teacher during the visit, and the third concerned the relationship between teacher-students-spaces and the exhibits visited.

Data deriving from these instruments were complemented by records of comments made by participating teachers during the course about their concepts of museum and museum-school relationship.

To systematise the data, three dimensions were used: **pedagogical practice alternative**, **scientific content** and **broadening of culture**. Such dimensions were chosen because the

science and technology museum institution has as a social attribution in its relationship with the school, that of improving scientific knowledge in the sense of broadening scientific culture and its relation to other cultures. Moreover, it offers the opportunity of using the museum as an alternative to pedagogical practice in school, not only a differentiated one, but one having its own particularities.

By computing the total frequency of each dimension in the observations as well as in the questionnaire, one can notice that it exceeds the number of subjects from the universe probed by the already described instruments. This fact occurs because dimensions are not exclusives, and can be mentioned at the same time by the same teacher. As for the records, systematisation was realised according to the same dimensions, but without quantification, as debate favoured exchanges and the complementation of one teacher's ideas by another. We have therefore selected what was recurrent. Sometimes, teachers' utterances recorded by the instruments could not be systematised according to the dimensions adopted. In such cases they were mentioned separately. Analysis was conducted of the systematisation in the light of the theoretical framework adopted.

Results

The teachers' concept of museum evidenced from the records collected during the first meeting of the course brings out an understanding related to characteristics that belong to the origin of museums, associating them with a "place for storage of objects", while recuperating the symbolic value of the objects as a source of knowledge, besides associating the museums to a place for teaching and research. Some of the teachers' utterances: "labyrinth-museum", "learning and creating upon the past, present and future", and "museum → antiquity → history → continuation → evolution and preservation", may well illustrate this notion. The teachers, however, don't make frequent references to science and technology museums, and when they do so, they don't show clearly the particular aspects of this sort of museum.

The analysis of the set of questions referring to planning, considering the adopted dimensions, showed that regarding the purpose of the visit, most teachers (22) take into consideration the **pedagogical practice alternative** dimension. The purpose of visiting a museum is to profit from alternative practices – other than schooling – since a museum is considered an alternative place for learning, where there is the possibility of exploration, interaction and practical observation of the many topics studied. Less than half the teachers (15) take into consideration the **scientific content** dimension, i.e. the fact that the purpose of the visit is related to the topics presented at Mast, which may be approached in an interdisciplinary mode, or in order to emphazise their relation with the students' daily life. The **broadening of culture** dimension as the purpose of the visit was mentioned by other teachers (15), reinforcing the importance of students visiting museums in order to create the habit of doing so, museums being in a position to facilitate an interdisciplinary reading of knowledge. Three teachers pointed out the socialising and emotional development aspects as the purpose of the visit.

A majority of teachers, when writing about the organisation of the visit as part of the planning, mentioned other elements besides the three dimensions considered for systematisation. Some (14) made reference to Mast and declared having made comments about what the students were going to see, or having advised them about the exhibits to be seen, thus creating expectations about the place. Others (11) organised the visit according to the

students, that is, they selected those who would participate, or chose to put the emphasis on the discipline aspect. A few (7) made comments of an administrative nature, mentioning such procedures as: requests for authorisation from school, from Mast or from the other teachers. Four teachers considered the organisation of the visit as a mandatory assignment of the course. It is worth pointing out that seven teachers declared not having done any planning whatsoever.

About the organisation of the visit, one could also notice in relation to the proposed dimensions that one teacher mentioned the use of didactic devices as a stimulating element. This falls into the **pedagogical practice alternative** dimension. Six teachers mentioned **scientific content** as one element used for planning, but in a different way: as another approach to academic curricular knowledge; as a facilitator of the sedimentation of knowledge in the classroom after the visit to Mast; as a means to awaken the interest for a subject. There is no direct reference to the **broadening of culture** dimension, although one teacher declared having oriented the students to pay attention in order to tell afterwards what they had most enjoyed. Finally, one should point out that some teachers stressed the importance of letting students visit the museum freely.

When commenting on the visit, from the total of teachers who turned in the questionnaire (41), many chose to describe it, and some of these (10) mentioned the students' attitude (interested, happy, fascinated, curious, aloof), while others (7) described the dynamics of the visit (group splitting, spaces visited and how it was organised). About one third (14) opted for an evaluation, qualifying the performance of the staff at Mast or the visit (productive, not productive, good, interesting, positive, boring, exhausting, etc.) and one of them pointed out as a problem the lack of habit among students of visiting museums.

Another set of comments was systematised, based on the three dimensions. Some teachers (13) stated that in the museum space one could experience an alternative **pedagogical practice**, especially in the case of interactive spaces. For these teachers, Mast constitutes a new, different space that stimulates thought and reflection, bringing about interrogations, hypotheses, besides being a place for leisure, learning, and developing questions that could later be brought to the classroom. Only three teachers commented on the visit from the **scientific content** dimension. They saw this content displayed in the pedagogical models that constitute the exhibits. Lastly only one teacher made comments falling into the **broadening of culture** dimension, calling attention to the issue of interdisciplinarity. Four teachers did not answer this set of questions.

As mentioned above, the other research tool used was the observation of the visit. Results have shown that, in relation to the **pedagogical practice alternative** dimension, the teachers can be classified in three types: the explaining type, the most frequent one, who offers guidance according to the students' requests or following his own initiative; the dynamic type, not so frequent, who explains, stimulates and raises questions; the neuter type, less frequent, who does not explain, does not offer guidance and does not raise questions. In relation to the **scientific content** dimension, most teachers explore it from the standpoint of the pedagogical models that constitute the exhibits. The **broadening of culture** dimension could not be found in the observations, indicating that the teachers made no reference to this topic during the visit.

Answers to the questions related to understanding the museum-school relationship pointed to the fact that a majority of the teachers (25) affirmed that this relationship should be implemented through educational actions. About half (16) of them considered such

actions to be of interest to the students, the teachers, or the school, as a means of articulating scientific and practical knowledge, and as a complement to schooling. Less than half (9) mentioned that the actions should be regular and continual. Such actions were seen as stimulating, motivating, enriching new practices. They were also perceived as a factor facilitating the transformation of how the concept of museum is viewed, favouring the propagation of the institution among students and parents.

Part of the teachers (14) did not explain how to establish the relationship, answering generically: "as an exchange", "an integration", "in a constant evaluation of the relation" and "complementary". Even those who gave examples didn't go further than mentioning activities like courses and projects, without specifying objectives. Some (6) declared that the relationship should be a direct one, without any intervention of other professionals coming from the schools or the state educational board.

Answers given by teachers about the museum-school relationship pointed towards the use of the museum as an instrument to meet the school needs. On the other hand, during exercises given at the end of the last class of the course about understanding the museum-school relationship, we identified that the teachers conceive the relationship in a different way, classifying it according to various types of exchange: continual, long-lasting, partnership. Exchanges were grouped according to the three dimensions adopted in this paper.

Regarding the exchange as a possibility for a **pedagogical practice alternative**, teachers consider the museum as: more concrete than a book; a stimulus for questioning and knowledge; a learning complement; a way of corroborating what is seen in theory at school; a de-structuralizing agent due to the presence of the object liberating and alive; a facilitator for experience, construction and interactivity. According to the **scientific content** dimension, teachers envisage the museum as a space to obtain knowledge, elucidation, enrichment, and to go back in history; a discipline integrator; a treasure of relics. In relation to **broadening of culture**, teachers, when making contact with the museum, find out that the visit "is more than a simple excursion". They re-elaborate their image of what is presented in this space as something good for "thinking the future". They observe the integration of diverse fields of knowledge in the approach of the same topic, and with that they verify that "things hide great complexity and must be probed".

Some teachers, however, understood exchange as a relationship that is established according to the needs of the school and the teacher. Thus, they suggested updating and recycling courses according to specific contents and the possibility of using the museum, coming closer to the view identified in the questionnaire.

Considerations

In general, the common-sense concept of a museum associates such a place to a deposit for a miscellany of dusty and old things, treated like trinkets. Nevertheless, participating teachers, when stating their concepts in the first meeting of the course, surprised us for having expressed an updated understanding of what a museum is. We noted though that they made no references to science and technology museums. This can be justified by the recent history of such institutions. In Brazil, this becomes a more serious factor as this kind of museum only came into existence in the 1980s.

From previous investigations carried out by the Educational Department at Mast, it was noted that teachers make a school-oriented use of the museum space. It is worth pointing out that, judging by the peculiarities mentioned during discussions about the changes and

the framework of science and technology museums, these institutions generated an expectation in the educational milieu, due to the fact of dealing with scientific contents by means of exhibits that are hard to replicate in school spaces. Thus, teachers have come to envisage these museums as complements to schooling. It is believed that this is one of the reasons contributing to the teachers' school-oriented view or attitude when using the museums. Strategies adopted in the course tried to reinforce the particularity of the museum, breaking with the school-oriented attitude.

Comparing the results of previous investigations with those herein, a tendency was observed on the part of the teachers towards using the museum in a different way from school. This element could be evidenced from the systematisation of data based on the three dimensions adopted. We were able to verify that the **pedagogical practice alternative** dimension is the most frequent one, having been made explicit in the data collection instruments. This dimension is manifested in two ways: alternative being understood as outside the school physical space, but reproducing school practices; and alternative being understood as different from the school.

The **scientific content** dimension is also fairly frequent in the results of all the instruments we used. Most of the teachers consider the museum as a place for obtaining knowledge, either hinged to the academic syllabus content, or according to an interdisciplinary approach. This latter possibility stresses the understanding of the museum space as a facilitator of the interdisciplinary approach, that is not always possible to implement in the school.

The **broadening of culture** dimension is the less frequent one, not having been evidenced in the observations. It is worth pointing out that, in previous studies, this dimension was not considered at all by the teachers, not even in their oral utterances. This points to an advancement towards a perspective that differentiates the school space from the museum space. On the other hand, it is clear that teachers incorporate the idea that the museum has a particularity of its own more easily in their speech than in their pedagogical practice during a visit to Mast. We beleive that this happens because effective changes require the combination of diverse strategies and a certain time to settle down.

Another aspect that deserves being addressed is the fact that teachers restated the importance of the exchange factor in the museum-school relationship. This exchange, however, points to the use of the museum as an instrument to meet the demands of the schools. Besides that, another form of understanding this exchange is evidenced and is systematised according to the three dimensions adopted. It should be noted that understanding exchange according to the three dimensions can be considered an advancement, insofar as it gives a real meaning to the term exchange incorporating the particularity of a museum.

In the museum, visitors can access other cultural horizons besides the neighbourhood, the school, and TV. Experiencing the museum space creates and broadens references to unveil the world (Lopes, 1991). School is a place where, in general, the praxis is to categorise topics, making them too fragmentary. In the museum, due to characteristics such as the absence of mandatory term-achievement policies in the learning process, with no time control and no academic syllabus to be accomplished, new conditions are created. These conditions expand relations among the diverse topics that constitute the museum's thematic focus, thus rendering this institution more culturally comprehensive.

Based on the analysis of the results, we observed signs of change on the part of the teachers in appropriating an updated conception of the museum, but a single isolated observation does not suffice to change the teachers' practices.

It is worth emphasising the fact that the three dimensions – **pedagogical practice alternative**, **scientific content** and **broadening of culture** –play an instrumental role in apprehending what teachers think about the museum-school relationship, and are clearly essential in the task of elaborating educational actions in museums.

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On Evaluation Research in Science Museums

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Abstract

The paper presents the methodologies applied in two different pilot researches carried out at the Museum of Astronomy and Related Sciences—MAST—during the years of 1994/95 and 1997. Both investigations aimed at evaluating the effectiveness of the interaction between MAST's scientific exhibitions and school children.

The researches were based on observations of the interaction patterns of selected groups of school visitors with the Museum's exhibited models. The groups were selected from those belonging to a special program for schools named "Atendimento Escolar" (Serving the Schools). Two different methodologies were applied in each research, both with the objective of extracting indicators of *what*, *how* and *how much* the visitors were able to learn in their interaction with the models.

The results provided guidelines for improving the Museum's models and enabled the establishment to draw a clear comparison between the two methodologies.

Introduction

Schools are not the only places where people have the opportunity to interact with scientific knowledge, nor with science as an intellectual activity. The different mass media (press, television, radio) and, more recently, the information nets create a suitable environment for enlarging and improving society's scientific initiation besides being able to illustrate the connection between information, leisure and learning in the modern world (Lucas, 1991).

Within this context, comparisons can be drawn between two great settings where knowledge can be produced and acquired: the school and the world outside of it.

The schools establish routines for conveying knowledge to their students. Learning takes place according to a well defined frame and there is a fixed timing for each pace of the school work. What and how to learn, as well as its duration, are determined by pre-established schedules. Teachers and students must, in their majority, execute and abide by these schedules which are considered essential for the success of the teaching-learning process development. According to Bourdieu (1983), the school routine is *homogenized* and *ritualized*.

In the world outside the school there is freedom of choice, as long as the cultural assets produced by society are made accessible for consumption. According to the followers of the Frankfurt school, these assets may be *legitimate* cultural manifestations: usually the

so-called shows/spectacles (theatre, books, concerts, museums), or *illegitimate*, i.e., entertainment produced by what may be labelled "cultural industry", like television and radio programs (Gouvêa de Sousa, 1997).

As part of the world outside the school, the museums play a basic role in broadening society's scientific knowledge and general culture. In particular, the so-called *interactive science and technology museums*, have been, since the beginning of the seventies, improving their environment towards becoming a non-formal setting for public scientific education and an important source of information to society in its process of acquiring scientific knowledge.

The interactive museums of science and technology are remarkable for stimulating the visitors to take part in their exhibitions, pressing buttons, turning cranks, handling equipment. The famous rule "DO NOT TOUCH" shall be replaced by "DO TOUCH" or "PRESS THE BUTTON". During the last twenty years, the specialized literature has showed numerical growth and, most importantly, improvement in the quality of interactive museums' programs and exhibitions, let alone their popular appeal, due not only to the interest of the schools in visiting museums, but also to the choice made by some families who look for interesting and educational options for using their spare time (Falk and Dierking, 1992).

The Ramey-Gassert (Ramey-Gassert, Walberg and Walberg, 1994) differences between the museum setting for non-formal education and the school setting for formal education—are listed in Table 1. These differences create the conditions under which the learning process takes place.

It is clear that certain interaction patterns between the visitors and the exhibition are established in the interactive museums that, according to Feher and Diamond (1980), are "a singular type of *research laboratory* suitable for observing and studying how people learn".

Table 1

Scientific Teaching and Learning Characteristics—Formal and Non-formal

Non-Formal Education	Formal Education
• volunteer	• compulsory
• not structured	• structured
• not sequential	• sequential
• evaluation without grade	• evaluation with grade
• without fixed end	• with fixed end
• conducts to learning	• conducts to teaching
• centred on learning	• centred on teaching
• out of the school-class context	• within the school-class context
• outside the frames of a curriculum	• within the frames of a curriculum
• many unexpected results	• few unexpected results
• the results are less measurable	• the results are measured empirically
• directed or non-directed learning	• directed teaching

Educational Research in Interactive Museums of Science

Educational research in interactive museums of science and technology appears and is rapidly prolific at the end of the seventies, with the general objective of informing about the nature of the learning processes experienced by the visitors, i.e., the quality of what is learned and how it is learned. Among the different factors that contribute to this situation, the following ones stand out:

1. The increasing number of interactive museums;
2. The idea of *learning by doing*, much spread in active scientific teaching, that now sets the guidelines when planning new exhibitions;
3. The orientation of the investigation according to new theoretical and methodological bases, a consequence of treating non-formal education according to cognitive and sociological perspectives.

Based on this scenario, several new lines of investigation have developed. There is a wide and heterogeneous universe of studies that may be grossly classified in two large groups: those on the nature of the visiting public (*who* comes and *why*) and those who analyze the factors influencing the results of the visit, such as previous knowledge and the visitor's symbolic universe. A recent line of investigation using an anthropological perspective proposes to use the visitor's point of view as its basis, while another investigates how the visit to the museum and what is experienced during the visit may affect the formal educational process—formal scientific learning—at different levels of education (Chagas, 1993).

Nowadays, researchers from different areas (education, psychology, sociology, anthropology, etc.) that deal with this type of museum are spotting opportunities for carrying investigations in the museums settings that try to expand the knowledge about human cognition and learning mechanisms, since learning is a particular aspect of human behaviour and museums are a particular type of social institution where learning is promoted and stimulated (Falk and Dierking, 1992).

Already in 1978, Kimche discussed the potential of learning in museums. According to him, the available data collected on this matter contain evidence of the *popularity* of exhibitions, instead of evidence of their *effectiveness* in transmitting information. Besides, he considers that the instruments of evaluation employed in pedagogical research are unsuitable for appraising the effectiveness of the museum experience:

> *If learning in a museum is a visual and scientific experience that qualitatively differs from the sequential school classes, then new models for evaluating this learning must be developed.*

Falk and Dierking (1992) point out the need for creating a specific learning model to study the interactions that happen in the museums as non-formal settings. In this perspective these authors formulate a general definition of learning, seeking to understand its mechanism in the museum setting.

> *For purposes of evaluation of learning in the museum setting, we need a broad definition of the term, encompassing the richness of experiences occurring within museums and emphasizing long-lasting memories and relationships. We need to develop a comprehensive museum-centred model that embraces certain elements of mainstream learning theories, but that prescribes a much stronger role for the variables as motivation, beliefs*

and attitudes of the personal context and for the influences of social and physical contexts.

The Museum of Astronomy and Space Sciences (MAST), through its Department of Education, is developing, since 1993, a line of research that aims at studying the nature of the process involved in the absorption of the information contained in the museums' exhibitions by the visiting public (with greater emphasis on school children) in order to expand and improve this absorption and, consequently, the public's scientific initiation.

Studying the patterns of interaction between the public and the exhibitions has provided clues to understand this process. The present work seeks to get a deeper insight in the methodologies adopted in two research being focused on understanding the patterns of interaction encountered when students visit exhibitions. Finally, an attempt is made to use the results as guidelines for redesigning the exhibition settings, making them more effective in transmitting information.

The Museum of Astronomy and Related Sciences

The museum was founded in 1985 as a consequence of the project "Memória da Astronomia e Ciências Afins" (Memory of Astronomy and Related Sciences) developed by the National Observatory. It is located in the old Observatory building and is responsible for keeping and preserving the collection of instruments and documents originated at that institution. The Museum's structure relies upon the tripod: preservation of the scientific memory, investigation of history of science and education for science. A more comprehensive characterization of the institution can be found in Cazelli (1992).

The Museum's permanent exhibition—*Quatro Cantos de Origem*—is located on the main building's first floor. On the ground-floor the following interactive exhibitions can be visited: *Laboratório de Ciências* (Sciences' Laboratory), *Ciclos Astronômicos e a Vida na Terra* (Astronomic Cycles and Life on Earth) and *As Estações do Ano: a Terra em Movimento* (The Seasons of the Year: the Revolving Earth).

The Sciences Laboratory, open to the public since 1988, is composed of interactive models that may be handled by the visitors and that illustrate some physical principles. These models show applications of certain rules and subsidise the understanding of a number of optical and mechanical phenomena. From the thirty-three that existed at the beginning of the Laboratory, ten were chosen to be kept: there are those that offered more intensive interaction with the public, caused the greatest impact because of the unexpected results obtained when handling them, and had the closest association with the school programs.

The exhibition "Astronomic Cycles and Life on Earth" is composed of devices for observation and/or manipulation (panels, displays, *dayoram* and interactive models), whose purpose is to offer an integrated view of the basic astronomical phenomena (days and nights, seasons of the year, eclipses, blue-sky and rainbow) and their relationship with life on earth. Besides, meteorological instruments of the Museum's collection, a chronology of space flights, a journey in space and a full scale model of the Sputnik, first satellite launched to space, are displayed.

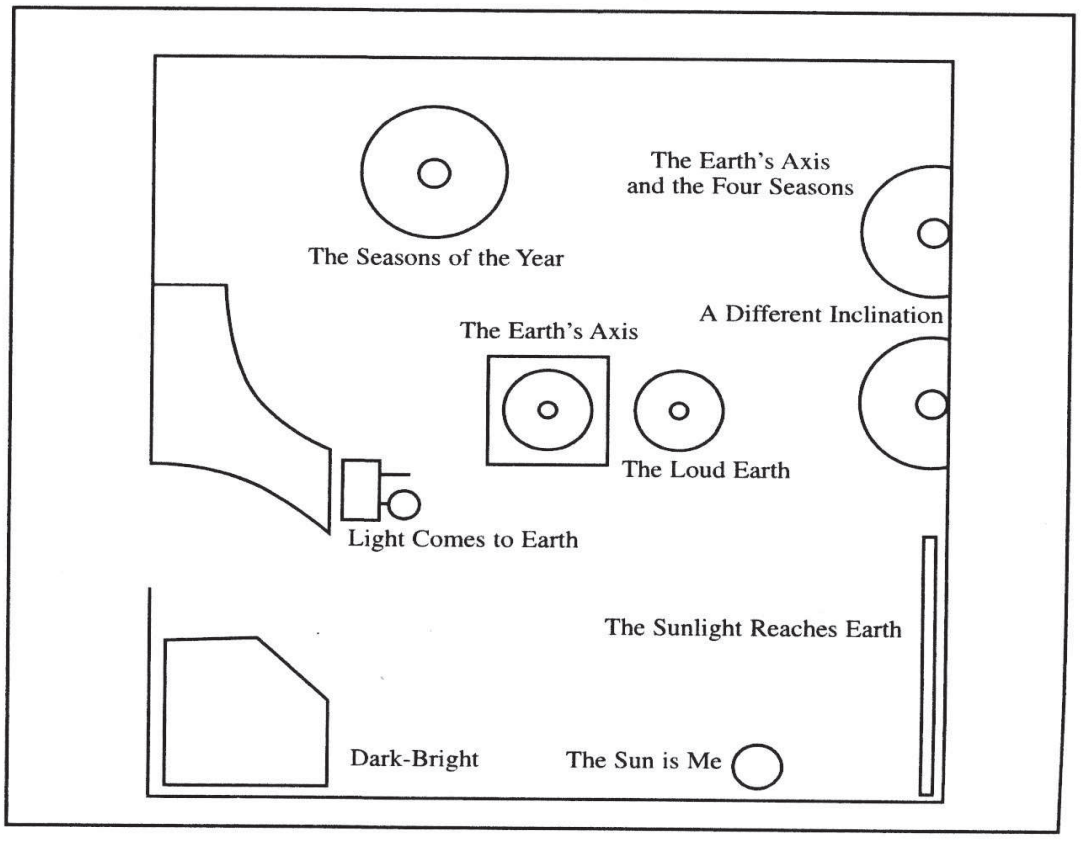
This exhibition makes use of a phenomenological approach and tries to convey an integrated view of the basic astronomical phenomena and how these are related to life. The Museum's aim was that, with the visitation, both the teachers and the students would

appraise an integrated comprehension of the exhibition and express an understanding of how the different phenomena affect the organization of life on earth, showing that the displayed elements did contribute to alter or improve their previous concepts.

The difficulties in manipulating the models of the exhibition "Astronomic Cycles and Life on Earth" indicated by a first research (1994-1995) were interpreted mainly as a consequence of the density of scientific information (several themes, many texts), presentation lay-out and design of some models. Thus, when designing a new exhibition on the same subject, only two key issues were selected: the cycle of days and nights and of the seasons of the year, taking into account all previous common knowledge about these two themes, mainly that of teachers and students, without loosing sight of the logic of science. Based on the elements extracted from this effort, nine models (devices) and three panels were built.

The exhibition "The Seasons of the Year: the Revolving Earth" aims at supplying elements to reelaborate the notions of the sequence of days and nights, as well as of the seasons of the year. Figure 1 shows the models' names and the exhibition room lay-out.

Figure 1
Exhibition Room Lay-Out



The Adopted Methodologies

The study of the interaction patterns in the exhibition "Astronomic Cycles and Life on Earth" (1994-1995) was carried out with school children and teachers that participated in the "*Atendimento Escolar*" (Serving the School) program, in an attempt to better understand how learning in museums takes place and how this may affect the relationship between teaching and learning at school.

The orientation of the study was initially provided by questions of both qualitative and exploratory nature, that outlined the character of the work.

1. What are the objectives of the exhibition "Astronomic Cycles and Life on Earth"?
2. What are the objectives of the teachers when programming the visit of their pupils to the Museum?
3. What type of interaction occurs between teachers-students-exhibition during the visit?
4. Which patterns would be characteristic of this interaction?
5. What indications of any form of learning can be found in the visit?

Since the study has a qualitative approach, the selected methodology was based on subjective approaches like direct observation, i.e., the researcher would follow the visit of a group of students and their teacher. During the second half of 1993, a number of pilot observations were carried out, indicating the need for audio and video-taping some areas of the exhibition and for interviewing children and teachers after a certain time (about one or two months). The children and teachers to be interviewed were chosen by drawing lots according to their class and the type of school (public or private).

From 1994 on, the observations were directed at taking notes of the conversations among children and teachers as of well as their attitudes. The visitors were informed that they were being watched and sometimes they did interact with the researcher, sometimes they did not. In the exhibition room "Astronomic Cycles and Life on Earth", the observations sometimes focused on the interaction with the exhibition as a whole, sometimes on some particular model/device, always taking special care in choosing the right moment of observation at each model/device. The same procedure applied to the video-taping used to support the personal observations.

Based on the hypothesis that memory serves as a reliable indicator that some kind of cognition has taken place during an experience or interaction, spontaneous recollections of any part of the exhibition were asked from the children. The fact that some experience is recorded in the childrens' memory implies that later they may use these recollections in learning situations, thus enabling the characterization of one type of interaction pattern. This information was obtained through interviews.

The interviews were audio-taped and started with an invitation for the child to talk about what he/she could remember. Then, interviewer would formulate questions based on the elements remembered by the interviewed and, in the end, would ask about aspects not mentioned spontaneously, using a photo album of the exhibited models as support. In the interviews with the teachers the interest was to have the following questions answered.

1. What are the objectives of the visit?
2. How did the students/teachers like the visit (based on spontaneous comments)?
3. What was found most important by the group?
4. What difficulties were encountered?
5. How will the visit unfold in the classroom?

Under the program "Serving the School" (1994), 96 schools, 120 teachers and 2.600 students visited the exhibition. The choice of the interviewed teachers (12), as well as of their pupils (12 boys and 12 girls), was made at random. To choose the school visits (37) and the audio and video-tapes (10 each) to be used for direct observation, lots were drawn, firstly according to the level of scholarity and, secondly according to the specific class degree. The final list was constructed in a way to cover all segments, degrees and levels of scholarity of the groups that took part in the program. The decision to stop the observations after the 37th visit occurred when data recurrence was detected.

These data were treated concomitantly by means of classifying the notes and the audio and video-tapes transcriptions, organizing the direct observations as well as reading and elaborating a synthesis for each observed school.

Based on these syntheses, three categories were established serving as references for classifying the models in three groups, according to

1. the difficulty in handling the device and understanding the associated phenomenon,
2. the facility in handling the device and difficulty in the understanding the phenomenon,
3. the facility in both handling the device and understanding the phenomenon.

The study of the interaction patterns in the new exhibition "The Seasons of the Year: the Revolving Earth" (1997) was again carried out with teachers and students who took part in the program "Serving the School". Working with the same public enabled a deeper understanding of how the relations between Museum and School take place.

The basic questions guiding this study were the three following ones:

1. What type of interaction occurs between teachers-students-exhibition during the visit to the modified show room;
2. How do these interactions compare to those observed during the original exhibition;
3. What are the potentials and limitations of the guidelines drawn for reformulating the exhibition?

To answer the proposed questions through this new study also qualitative, instruments like direct observation were again used. Each researcher picked a child at radom and watched him during his visit. The researcher's task was to classify the interaction of the child with each of the visited models, based on three categories drawn from the theoretical studies of Shettel (1973). These are: power of attraction—if the child remained five seconds or more interacting with the model; power of retention—absolute measure of the time the student spent interacting with the model; level of engagement—quality of the power of retention, which includes the model being watched without being touched, its inappropriate use, its appropriate operation with or without following the written instructions, as well as discussing and sharing his/her comments with other children and/or teachers.

Tables were constructed with the collected data, organizing the models hierarchically according to each of the three utilized categories. As an example, Table 2 relates the data to the category "level of engagement".

Comments

The results obtained with the study of the interaction patterns point out difficulties in the communication mechanisms of the exhibition. However, it is important to emphasise that this study may guide the reformulation of several aspects of the exhibition.

Table 2
Power of Retention

MODELS	Total Number of Visits	Watching/ Inadequate Use	Appropriate Use and Adequate Use by Reading the Instructions	Sharing Comments with Mates and/or Teacher	Power of Retention (Time of Permanence in Seconds)
Loud Earth	51	55.00%	33.20%	11.80%	62
Seasons of the Year	41	51.20%	39.30%	19.50%	33
Light Comes to Earth	36	50.00%	36.10%	13.90%	49
Dark-Bright	35	2.85%	71.45%	25.70%	59
Axis of Earth and the Four Seasons	3	54.50%	36.40%	9.10%	40
The Sun Is Me	33	19.40%	74.40%	3.20%	67
Axis of Earth	31	38.70%	58.10%	3.20%	20
Different Inclination	14	50.00%	42.90%	7.10	27
Sunlight Reaches	10	80.00%	20.00%	–	12

Thus, in the study of the exhibition "Astronomic Cycles and Life on Earth", the methodology used gave a global and clear picture of the impact the exhibition made on the child. In this sense, the proposed reformulation reached both the whole presentation concept and the choice of the content/subject and not just one or two models.

The exhibition "The Seasons of the Year: the Revolving Earth" also presents a phenomenological and interactive approach but focuses solely on the cycles of day and night and of the seasons of the year.

The methodology chosen to investigate the above mentioned exhibition was able to thoroughly depict the interaction of each child with the model, letting its qualities or limitations emerge, what allowed reformulation of the individual devices without having to rethink the exhibition's global structure.

Comparing the interaction patterns obtained through the two methodologies, one may observe that the first investigation depicts more precisely how the affective relations of the group with the Museum take place.

The children establish an open relationship with the Museum and are prone to use it as a leisure space. They manipulate the models, exchange information, ask questions both to the teacher and to the researcher. Besides, they associate what they experience with previous references, they become emotional and excited and simply ignore some of the displayed models.

Nevertheless, during the second investigation, the way the observation was conducted did not allow the collection of information about the affective relations established between groups and models and among children, because only one of the used classifying categories contained any information on this type of relation but mainly because the observation was centred on one student at a time.

Besides that, one consequence of analysing the results of these researches may be pointed out: the study with different cognitive concepts. Another consequence is the possibility to better understand the production and absorption of knowledge both in the Museum and at School, thus establishing a more cohesive relation with the latter, without neglecting the particularities of these different institutions.

In the first research, the museum setting is not considered indispensable for the process of learning, but only one more player within the rich dynamics of the cognitive process, having the privilege to be a knowledge conveyor where social interaction is more intensive. Thus, the museum is just one more learning space, like many others of our society. The exchange between mates during the experience in all areas of the exhibition, the opportunity to read the informations together and to exchange ideas, the free schedule and the teacher's presence and mediation allow a privileged opportunity to collectively absorb the information. The child who is on a lower development level learns under the influence of those who are on a higher level. This mechanism is in accordance with Vygotsky's (1987) concept of development zone (*Zona Proximal de Desenvolvimento*) which is based on the principle that the personal absorption of a given information is influenced by the children's interaction with others in different contexts.

In the second research, the Museum pursues its role as a non-formal educational setting. There is no obligation, no formal teaching-learning process. The museum is characterized by the freedom of choice: choice of what shall be tried and observed, choice of the time of interaction with the displayed models. The user is naturally involved by the mechanisms that promote knowledge absorption and there is no performance demanded of the visitor.

In this investigation, the observations focus on the child and unveil his/her notions of the phenomena encountered in the exhibition "The Seasons of the Year: the Revolving Earth".

These data may be used as one of the elements in the study of models and modelling in museums, since for the child to learn to build and express his/her *mental models*—private and personal notion—it is necessary to promote situations where explicit opportunities are set forth. Gilbert and Boulter (1996) also studied models and reports in other outside the school contexts like museums. They indicate that these settings include both the *consensual model*—an explicit model that has been subjected to a test by a social group like, for example, the scientific community—and the *pedagogical model*—specially constructed to aid the understanding of a consensual model—the latter with great interactive possibilities, not mentioning the objects (replicas or originals) and texts.

Still according to these authors, the children who visit museums learn through interaction among themselves, with the teachers, with the help of other adults, through the objects' lay-out and the relation between their personal perception of the experience and their knowledge. As such there is a *humanization* process of this setting accomplished by the child himself in a way that insures the existence of motivation for learning through obtaining answers to his/her questions, building up, like that, his/her own scrip or the group's.

The two methodologies allowed for the evaluation of the effectiveness of the exhibitions. The first shows that the MAST's environment is suitable for developing concepts where social interaction and shared knowledge stand out, characterizing itself as an adequate space for sociological research. The second also indicates that the MAST's environment is suitable for developing concepts where the interaction child-model is important, being suitable for educational researches in the field of psychogenesis. Both provide elements for understanding this very particular setting which are the museums.

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Papers

LA BIODIVERSIDAD EN EXPOSICIONES INMERSIVAS DE MUSEOS DE CIENCIAS: IMPLICACIONES PARA EDUCACIÓN EN MUSEOS

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Resumen. El artículo analiza cómo se presenta la biodiversidad en dos exposiciones inmersivas de museos de ciencias: una del Biodôme/Canadá y otra de la Fundación Zoobotánica/FZB/Brasil. La metodología de la investigación fue cualitativa y se analizaron los textos y los objetos de las exposiciones. El referencial teórico profundizó el concepto de biodiversidad y de museografía ambiental. Se identificó la presencia de casi todos los abordajes de biodiversidad en ambas exposiciones, con un énfasis en la conservacionista; se encontró la evolutiva solamente en la FZB. Sobre la museografía ambiental, las exposiciones enfatizan representaciones ecocéntricas y, en un menor grado, antropocéntricas; la biocéntrica aparece incluso menos. Se discutieron las implicaciones educacionales de los resultados por medio de un análisis crítico de la dimensión educativa de los museos de ciencias.

Palabras clave. Educación en museos, biodiversidad, exposición, inmersión, museo de ciencias.

Biodiversity in immersion exhibitions in science museums: implications for museum education

Summary. This article examines the way in which biodiversity is presented in two immersive exhibitions of science museums: one from Biodome/Canada and other from Zoobotanic Foundation/FZB/Brazil. The research methodology was qualitative and it analyzed the texts and objects of the exhibition. The theoretical framework deepened in the concept of biodiversity and environmental museography. We identified the presence of almost all approaches to biodiversity in both exhibitions, with special attention to the conservational one; the evolution approach was found only in FZB. We also verified that the environmental museography of the exhibitions is more ecocentric then anthropocentric and even less biocentric. The educational implications of these results are discussed, trying to analyze the educational role of the science museums.

Keywords. Museum Education, biodiversity, exhibition, immersion, Science Museum.

I. INTRODUCCIÓN

La cuestión de la extinción de la biodiversidad en todo el planeta es un fenómeno altamente preocupante y urgente. En 1992, representantes de 156 países firmaron la Convención sobre la Diversidad Biológica durante la Conferencia de las Naciones Unidas sobre el Medio Ambiente y el Desarrollo, CNUMAD, que refuerza la necesidad de acciones directamente dirigidas hacia el cambio de ese cuadro.

Edward Wilson, investigador de la Universidad de Harvard, que introdujo el término *biodiversidad* en 1988, calcula que, en las florestas tropicales, donde está la mayor diversidad biológica, cerca de un 0,25% de las especies están extintas o están amenazadas de extinción cada año (Wilson, 2002). Brasil es uno de los países de mayor diversidad biológica, pues abriga del 15 al 20% del número total de especies del planeta (Joly, 2001; Mittermeier et al., 1997). En países como Canadá, la diversidad de formas de vida y de ecosistemas también es grande. Sus paisajes incluyen desde florestas húmedas hasta desiertos, con montañas y planicies y cada una tiene especies adaptadas a sus condiciones[1]. En ese sentido, entender este concepto, su importancia y sus implicaciones en

el ámbito de la educación y divulgación de la ciencia y de las discusiones sobre conservación ambiental se convierte en algo imprescindible, no solamente en estos dos países, sino en todo el planeta.

Aparentemente el aprendizaje y la enseñanza del concepto de biodiversidad parecen fáciles. De modo más amplio, se puede definir como el conjunto de los diferentes seres vivos, tanto en lo que se refiere a su constitución genética como a la interacción de esos seres entre sí y con los ecosistemas en los que se encuentran, además de los procesos ecológicos que los rigen. Sin embargo, el término es polisémico y su comprensión, paso importante para la educación hacia la biodiversidad, involucra una red de informaciones, ideas y conceptos, tanto en el ámbito de la ciencia como en las diversas formas en que la sociedad se ha apropiado del mismo.

Levêque (1999) afirma que se atribuyeron varios significados distintos a ese concepto, lo que vacía de cierta forma su sentido original. Según este autor, se introdujo el término en la mitad de los años 80 y se ha popularizado en el contexto de la firma de la Convención sobre la Diversidad Biológica[2], en el evento que se conoció como Río-92. Motokane (2005), a su vez, destaca que el uso del término biodiversidad no ha sido un consenso, pues se pueden encontrar significados científicos, políticos e incluso simbólicos.

Oliveira (2005), en una investigación sobre el concepto, indica que varias de las referencias consultadas apuntan a la presencia de tres principales categorías –variedad de genes, de especies y de ecosistemas– que pueden aparecer en conjunto, en una única definición o evidenciar esta o aquella categoría. Para el autor, hay también estudios que consideran otras variables y aspectos relacionados con la biodiversidad, como factores sociales, económicos, culturales, estéticos, etc. Weelie y Wals (2002) refuerzan también la existencia de comprensiones referentes a la política internacional, a la apreciación y a la contemplación estética, para promover la comprensión, por el ser humano, de la naturaleza y de sí mismo.

Al tener en cuenta las diferentes influencias que el término biodiversidad recibe para su conceptuación, muchos son los desafíos cuando se trata de la educación dirigida hacia ese tema. Algunos autores han destacado la importancia del desarrollo de esta temática en el ámbito escolar para un efectivo y necesario cambio en la relación del ser humano con el medio ambiente (Gayford, 2000; Vilches y Gil Peres, 2003). Esa percepción se agravó aún más con la divulgación de los informes sobre cambios climáticos[3], lo que llevó a la constatación de que la educación hacia la biodiversidad no puede, hoy día, prescindir de la dimensión conservacionista. Además de la escuela, otros espacios educativos como los museos son llamados a colaborar en esa perspectiva (Brown, 1997; Mehrhoff, 1997; Davis, 1999).

Especialmente con relación a los museos, desde el origen de los Gabinetes de Curiosidades del siglo XVI hasta los museos científicos del siglo XIX, la diversidad de organismos vivos estuvo presente en esos sitios, tanto en las colecciones e investigaciones como en las exposiciones y acciones educativas. A lo largo de esos años la forma de presentar los organismos se fue alterando, en función de los cambios en las concepciones de ciencia, de museografía, de comunicación y de educación (Van-Präet, 1989; McManus, 1992; Porcedda, Landry y Lepage, 2006). Tales cambios nos llevan a analizar las formas por las que se ha presentado la biodiversidad en las exposiciones de los museos y qué tipo de museografía dirigida al medio ambiente se ha enfatizado en esos lugares, temas centrales en este trabajo.

II. LAS EXPOSICIONES INMERSIVAS COMO OBJETO DE ESTUDIO EN LA EDUCACIÓN EN MUSEOS

Los museos de ciencias, especialmente a partir del siglo XX, han estructurado sus acciones basados en un fuerte componente educativo. El proceso de elaboración y análisis de exposiciones ha sido objeto de estudio y reflexión en esos lugares (Belcher, 1992; Dean, 1994; Mcdonald, 1998; Wagensberg, 2000), y ha recibido aportes de las discusiones en el ámbito de la divulgación de la ciencia, de la educación y del movimiento ambiental (Van-Praët y Poucet, 1992; Crenn, 2003; Pedretti, 2004; Mazda, 2004; Marandino, 2005). Así, se destaca la importancia de estudiar la educación en museos en función de sus exposiciones.

Varias exposiciones encontradas en museos de historia natural, centros de cultura científica, jardines botánicos y zoológicos tratan del tema de la diversidad biológica y/o de los problemas ambientales. Sin embargo, hay una nueva forma de concebir exposiciones en el ámbito de las ciencias de la naturaleza que se asemeja a los jardines botánicos y zoológicos por exponer organismos vivos. Son exposiciones y/o museos que buscan reproducir de la manera más «real» posible los ambientes en donde esos organismos viven, en el intento de proporcionar la *inmersión* total de los visitantes en esos lugares, como si estuviesen visitando el ambiente original. Se están utilizando las *exposiciones inmersivas* cada vez más en los museos con la función, entre otras, de posibilitar una experiencia simultáneamente afectiva, sensitiva y cognitiva. En general utilizan diversas técnicas museográficas que estimulan los sentidos –olfato, visión, audición y tacto– asociadas a informaciones científicas presentadas muchas veces de forma interactiva.

Se ha trabajado la idea de inmersión en diferentes campos del conocimiento y en varias experiencias en las artes, en la comunicación y en la educación. Björk y Holopainen (2005) indican que se puede dividir la inmersión en las categorías sensorio-motora, cognitiva y emocional, lo que evidencia las dimensiones involucradas en experiencias de esa naturaleza. Belaën (2005) discute cómo los museos de ciencias se han apropiado de esa forma especial de elaborar exposiciones fuertemente ancladas en el espectáculo, lo que proporciona emociones fuertes y memorables. Montpetit (1996) analiza el desarrollo de la museografía y presenta la experiencia de las exposiciones de inmersión afirmando que son fuertemente ancladas en referencias de situaciones del mundo real[4].

Especialmente en lo que atañe a las ciencias naturales, esas exposiciones representan biomas, ecosistemas o hábitats de organismos, por medio de mezclas de ejemplares vivos, réplicas y modelos. Así, se crea un ambiente afectivamente estimulante para que el público pueda experimentar las sensaciones que en general tendrían en la naturaleza. De ese modo, las exposiciones inmersivas se están convirtiendo en una estrategia educativa de los museos de ciencias, lo que hace importante analizarlas por su especificidad.

Se pueden identificar investigaciones que buscan discutir las cuestiones relacionadas con el medio ambiente y con la biodiversidad en exposiciones de museos (Brown, 1997; Futter, 1997; Krishtalka y Humphrey, 1998). Porcedda, Landry y Lepage (2006) discuten el tema con la finalidad de comprender el papel del concepto de «desarrollo sostenible» en la elaboración de una exposición y analizan si ésa es una forma de militancia de los actores museísticos o el indicio de un verdadero cambio en los museos. Marandino y Mônaco (2009) enfocaron las formas por las que dos museos brasileños y uno francés presentan el tema de la biodiversidad por medio de sus exposiciones. En este estudio, se evidenció que la dimensión conservacionista de la biodiversidad no es un elemento central en los dos museos brasileños estudiados –un zoológico y un museo de zoología– aunque no estuvieran totalmente ausentes de sus exposiciones. El ejemplo de Muséum de París, en ese estudio, se consideró paradigmático, una vez que en su concepción los variados abordajes de biodiversidad fueron contemplados. Incluso aunque se trate de un museo con características diferentes de aquellos estudiados en Brasil, el hecho de que esa exposición plantee el tema de la conservación lleva a una reflexión profunda respecto a las instituciones de divulgación de la biología en el contexto actual de pérdida de la biodiversidad.

Este artículo presenta el análisis de dos *exposiciones inmersivas* en dos museos, uno canadiense y uno brasileño, en los que se busca caracterizar el discurso sobre biodiversidad presentado en esos lugares y las implicaciones educativas para sus visitantes. Son el Biodôme, ubicado en Montreal/Canadá, y la Fundación Zoobotánica, ubicada en la ciudad de Belo Horizonte/Brasil. Los datos obtenidos se analizaron a fin de caracterizar los abordajes de biodiversidad y la museografía ambiental de esas exposiciones.

III. METODOLOGÍA

Para ese estudio, se desarrolló una metodología con base en la investigación cualitativa aplicada al campo educacional. La investigación cualitativa, según Bogdan y Biklen (1994), tiene como algunos de sus presupuestos el hecho de que la fuente de datos es el ambiente natural y éstos son recogidos en situaciones específicas. En ella, el proceso es más valorado que el producto, en la búsqueda de comprender la forma de negociación de significados por los sujetos involucrados. En este trabajo, se buscó adaptarla a las características de la investigación cualitativa para los espacios de museos. Algunos autores discuten las investigaciones cualitativas desarrolladas en el campo de la educación no formal, en especial en la educación en los museos (Diamond, 1999; Baile et al. 1998). Según Diamond (1999), la investigación cualitativa enfatiza la comprensión más profundizada para la generalización de los datos y es muy efectiva para el estudio de los fenómenos complejos difíciles de resumir en categorías discretas, como aquellos que ocurren en las acciones educativas y culturales en museos.

En la investigación aquí presentada importa saber la manera por la que se da la producción de las *exposiciones inmersivas* en la búsqueda por entender las perspectivas sobre biodiversidad por ellas enfatizadas, en la que la investigación cualitativa es más adecuada a los objetivos pretendidos. Para eso los datos recogidos enfocaron tanto las informaciones sobre su propuesta conceptual (científica y museográfica), obtenidas vía documentos y entrevistas, como los elementos relacionados con los objetos y textos que las componen, que son los datos empíricos principales.

En los últimos años la investigación relacionada con las exposiciones y/o actividades culturales y educativas en museos se ha intensificado, volviéndose cada vez más un campo de producción de conocimiento por medio del estudio de las interacciones de los visitantes de manera que apoyen el trabajo de los *designers* (Bailey et al., 1998; Diamond, 1999). Crece el número de investigaciones sobre exposiciones de museos con enfoque educativo y se mejoran los métodos de análisis para su estudio y desarrollo con el objetivo de perfeccionar cada vez más la dimensión educativa de esos medios.

La educación no formal que se desarrolla en los museos involucra una didáctica específica (Girault y Guichard, 2000), en la que los aspectos pedagógicos relacionados con el tiempo, el espacio, el objeto y el lenguaje por medio de los textos ganan contornos propios (Van-Präet y Poucet, 1992; Marandino, 2005) y se concretan en la exposición. Ésos son los elementos fundamentales de educación y de comunicación en los que los fenómenos científicos se presentan al público y en que ocurren los procesos de enseñanza y aprendizaje en los museos. Se constata, de ese modo, la importancia de estudiar las exposiciones como parte del proceso educativo de esos lugares.

Se buscó, en este trabajo, analizar las *exposiciones inmersivas* existentes en dos museos de países distintos, y para eso se tuvieron en cuenta algunos de sus elementos principales como los objetos y los textos[5]. La elección de las exposiciones se dio por la relevancia de las instituciones en donde se encuentran y por la importancia que la cuestión de la biodiversidad tiene en esos lugares.

Los procedimientos utilizados fueron la observación de las exposiciones, el análisis documental y las entrevistas. Se buscó garantizar el rigor de la investigación cualitativa a partir de la triangulación de los datos obtenidos por esas tres fuentes y del análisis en la confrontación con el referencial teórico construido. El análisis final se realizó a partir del diálogo entre los datos recogidos y las categorías propuestas sobre los abordajes de biodiversidad (Marandi-

no y Mônaco, 2009) y sobre museografía ambiental (Porcedda, Landry y Lepage, 2006). Se describen y se analizan las instituciones estudiadas –Biodôme/Canadá y Fundación Zoobotánica/Brasil– en el ítem a continuación. Las etapas de recogida y el análisis de datos fueron:

• **Recopilación de informaciones** generales sobre las exposiciones en sitios o en documentos institucionales de divulgación (catálogos, folletos y película institucional).

• **Observación** de la exposición a partir de guión previamente elaborado y hecho por medio de visita técnica, enfocando los abordajes de la biodiversidad y la museografía, con un registro fotográfico y una filmación. Tal instrumento de recogida fue el de mayor importancia y el eje central del trabajo.

• **Análisis del material** referente a documentos, proyectos y publicaciones sobre las exposiciones estudiadas. Al ser poco representativo y por la diversidad de la cualidad del material institucional, ese instrumento fue complementario a las observaciones.

• **Entrevista** hecha a un responsable de la exposición y de los sectores educativos de cada museo, en función de un guión semi-estructurado, con foco en los abordajes de biodiversidad y en la museografía. Tal entrevista se realizó durante la visita técnica a la exposición y se trata de un dato complementario a las observaciones realizadas.

Las categorías de análisis sobre los abordajes de biodiversidad se construyeron en función del trabajo de autores que discuten tanto el concepto de la biodiversidad en el ámbito académico, como el estudio de la biodiversidad en contextos de educación y divulgación (Levêque,1999; Weelie y Wals, 2002; Gayford, 2000; Motokane, 2005; Oliveira, 2005). Las categorías propuestas tratan, de ese modo, de caracterizar cómo se presenta la biodiversidad en los museos, y son las siguientes:

• **Niveles de organización:** cuando el tratamiento dado al tema de la biodiversidad enfatiza los niveles de la organización de la diversidad, o sea, la dimensión de la especie (variedad de taxones), genética (variedad de genes entre individuos, poblaciones y taxones) y de ecosistema (variedad de taxones y ambientes físicos en el que se encuentran). En ese abordaje también se incluyeron aspectos relacionados con el comportamiento de los seres vivos en los diferentes niveles de organización.

• **Biogeográfica:** cuando el tratamiento dado al tema enfatiza las dimensiones de tiempo y/o espacio, lo que incluye la distribución de los organismos en un período de tiempo y/o geográficamente.

• **Evolutiva:** cuando el tratamiento dado al tema enfatiza la dimensión temporal y presupone la variación de uno o más grupos de organismos a lo largo del tiempo y establece relaciones de ancestralidad.

• **Conservacionista:** cuando el tratamiento dado al tema enfatiza las implicaciones sobre el mantenimiento de especies y/o de ambientes amenazados.

• **Humana:** cuando el tratamiento dado al tema incluye de alguna forma el ser humano. En general, el abordaje se hace de dos maneras: el ser humano como una más de las diversas especies o como elemento central, en que se enfatiza la diversidad de los aspectos culturales, sociales y económicos de la humanidad. En ese caso, el ser humano aparece sin relación con aspectos de conservación.

En función de esas categorías, se realizó el primer análisis de las exposiciones. En la segunda etapa, se analizaron los aspectos museográficos en la relación directa con las cuestiones sobre el medio ambiente. En ese análisis se propuso una tipología museográfica basada en los trabajos de Van-Präet (1989, 1995) y Porcedda, Landry y Lepage (2006).

Los estudios sobre la relación entre las ciencias naturales y las exposiciones de museos resaltan las articulaciones entre el desarrollo de la historia natural y la manera de exponer ese campo de conocimiento (Porcedda, Landry y Lepage, 2006; Girault y Guichard, 2003; Van-Präet, 1989, 1995). Van-Präet (1995) realiza una reconstrucción histórica de los museos de historia natural, resaltando las contradicciones y los marcos en la relación entre colección y exposición a lo largo de los siglos. Según ese autor, del siglo XV al XVII, las ciencias naturales pretendían esencialmente hacer un inventario exploratorio de la riqueza del globo y las galerías serían espacios de almacenaje de toda la riqueza recogida. A lo largo del siglo XVIII las exposiciones comenzaron a incorporar las nuevas concepciones científicas, y el desarrollo de la clasificación de los objetos científicos tiene como gran referencia el trabajo de Linneo (1707-1778). Los museos de historia natural del siglo XIX tuvieron como marca la preocupación didáctica en sus exposiciones y, en esa época, se procesó la disociación entre colección y exposición y la organización de exposiciones temáticas. Según Van-Präet (1995:60), esas exposiciones tuvieron como marco la publicación del *Origen de las Especies* de Darwin, en 1859. Para ese autor (ibíd., p. 62) el desarrollo de los *dioramas*[6] al final del siglo XIX representaron la gana de hacer museografía con los procesos de la naturaleza y respondieron al deseo de poner en escena los conceptos de biogeografía y ecología.

El siglo XX marcó, para Van-Präet, la crisis de los museos de ciencias naturales. En ese período la ecología se afirmó como ciencia e impuso una nueva temática museológica. Las presentaciones basadas en los dioramas constituyen, de esa manera, una verdadera ruptura entre la investigación con base en las colecciones y en las exposiciones. Esta nueva museografía parece no haber alcanzado todos los Museos de Historia Natural (Fortin-Debart, 2003 apud Pocedda, Landry y Lepage, 2006; Valente, 1995)

De acuerdo con Porcedda, Landry y Lepage (2006), Fortin-Debart (2003) en su trabajo sobre la educación y medio ambiente, identificó un paralelismo entre el desarrollo de las ciencias naturales y de las exposiciones. De ese modo, esos autores caracterizan una evolución sobre las formas de exponer el medio ambiente en los museos y proponen

una tipología de representación basada en el análisis de exposiciones de carácter ambiental. Los autores sintetizan esa tipología en el siguiente cuadro:

Representación del medio ambiente	Museografía	Ciencia	Época de surgimiento
Biocentrismo	Especímenes naturalizadas presentadas según su taxonomía	Taxonomía, historia natural	Siglo XVI
Ecocentrismo	Dioramas: interacciones hombre-naturaleza son evocadas	Ecología científica	Fin del siglo XIX y comienzos del siglo XX
Antropocentrismo	Problemas que afectan a los seres humanos son evocados	Incorporación de las preocupaciones sociales en la ecología científica	Mediados del siglo XX

Siendo así, una representación del medio ambiente emerge en el siglo XVI, apoyada en el *biocentrismo,* en la que los ejemplares naturalizados se presentaban según su taxonomía y que refuerza la importancia de todos los seres vivos, en la que la igualdad entre las especies es el principio básico de la unidad de la biosfera. Entre los siglos XIX y XX, surge un tipo de representación *ecocéntrica*, en que el centro es el hábitat, con el foco en los ecosistemas y cuando los dioramas evocan las relaciones entre seres vivos y entre ellos y los factores abióticos. A partir del siglo XXI, según los autores, se representa el medio ambiente de *forma antropocéntrica*, en el que se evocan los problemas que afectan a los seres humanos, consecuencia de las preocupaciones sociales asociadas al medio ambiente y a su conservación. En ella el ser humano es el centro del mundo y el bien de la humanidad la causa final de todas las cosas.

Las características que la museografía de las exposiciones dirigidas al tema del medio ambiente asumieron con lo largo de los años nos lleva a reflexionar sobre cómo ésas presentan hoy en día los aspectos relacionados con la biodiversidad a sus públicos y en qué medida incorporan los elementos mencionados. Por otro lado, nos lleva a problematizar la idea de patrimonio ambiental, tanto en lo que se refiere a su conceptuación como a las implicaciones sociales, políticas, culturales y ambientales de la creación y recreación de áreas protegidas como patrimonio de la humanidad. Además, se pueden también formular cuestiones sobre las implicaciones educacionales de representaciones antropocéntricas sobre el medio ambiente cada vez más presentes en exposiciones de museos. Así, considerando tanto los cambios en la forma de exponer las ciencias naturales en los museos como la evolución en la museografía sobre el medio ambiente, se analizó la Floresta Tropical de Biodôme y los Invernaderos Temáticos da FZB-BH buscando identificar cómo esas exposiciones contemporáneas representan aspectos relativos a la biodiversidad. Para ello, se consideró oportuno usar las categorías de biocentrismo, ecocentrismo y antropocentrismo, ya que expresan de modo objetivo y sintético los aspectos mencionados. Aun sabiendo que tales categorías se usaron para describir la evolución histórica de la museografía ambiental, argumentamos que esas representaciones no congelaron en el tiempo y, aquellas que se originaron hace siglos pueden convivir hoy con las museografías contemporáneas. Además de convivir, el hecho de que puedan o no ser identificadas en exposiciones actuales puede revelar continuidades y tensiones en las formas con las que los museos hoy día presentan los aspectos de la biodiversidad referentes a las relaciones entre el ser humano y el medio ambiente, siendo la finalidad de este trabajo discutir tales aspectos.

IV. BIODIVERSIDAD EN LAS EXPOSICIONES INMERSIVAS ESTUDIADAS

Se eligieron para este estudio el Biodôme ubicado en Montreal, Canadá, y la Fundación Zoobotánica de Belo Horizonte, en Brasil. Para este análisis, realizamos la descripción de los espacios tratando de evidenciar aspectos relacionados con los objetos y los textos existentes en las exposiciones inmersivas estudiadas que pudiesen ofrecer elementos para el análisis de los abordajes de la biodiversidad y de la museografía ambiental de esos lugares. También se consideran los datos obtenidos en los documentos y en la entrevista a los responsables por las exposiciones para complementar el análisis.

Se creó el Biodôme (*Bio = vida; dome = casa)* en 1992 y, junto con el Jardín Botánico, el Insectario y el Planetario, forma parte del complejo llamado «Museos de Ciencia» de la ciudad de Montreal, en Canadá. Ese sitio es un espacio que presenta la reconstrucción de cinco ecosistemas con organismos vivos (aproximadamente 750 especies de plantas y 230 especies de animales): Floresta Tropical, Floresta Laurentiana, Ecosistema Marino de Saint-Lawrence, Ártico y Antártida. Anualmente recibe 900.000 visitantes.[7]

Durante la visita, es posible que se recorran los espacios que reproducen los varios ambientes naturales y que se observe la diversidad de especies, de comportamientos y de adaptaciones de los diferentes organismos. La museografía contempla factores bióticos y abióticos que se recrearon para posibilitar el mantenimiento de los seres vivos en los ambientes. En este estudio seleccionamos el espacio «Floresta Tropical» para su descripción y análisis.

La Fundación Zoobotánica de Belo Horizonte, en Brasil, posee un área de 1.440.000 m², creada en 1991 e integra la administración del Ayuntamiento de Belo Horizonte. Recibe anualmente 1,2 millones de personas y desarrolla proyectos educativos, científicos y culturales con la finalidad de promover la preservación de la naturaleza y la formación del ciudadano. Reúne en su área el Jardín Zoológico y el Jardín Botánico, además de otros espacios expositivos como el Mariposario, formado por un invernadero con mariposas libres y la Zooboteca, una biblioteca interactiva sobre animales y plantas. En este

estudio enfocamos el Jardín Botánico, que ocupa 10 hectáreas del área total de la Fundación. Para el análisis, seleccionamos el conjunto de los invernaderos, que abordan los siguientes temas: Campo Rupestre, Caatinga, Mata Atlántica y Evolución.

El primer aspecto que se destaca se refiere a las finalidades de las exposiciones estudiadas. Ambos pertenecen a instituciones renombradas en sus países que fueron creadas con objetivos bien definidos tanto en lo que se refiere a la importancia de divulgar conocimientos científicos para el público, como a la preocupación por cuestiones dirigidas a la preservación del medio ambiente. Según se puede ver en la documentación y en la exposición, ambas instituciones asumen el papel no sólo de desarrollar acciones de conservación de la naturaleza, por medio de investigaciones científicas, manejo de organismos vivos, trabajo conjunto con instituciones de conservación, sino de promover actividades dirigidas hacia la educación para la biodiversidad. Esa intención se evidenció también en las entrevistas y en las observaciones hechas en las exposiciones estudiadas. Como afirma el responsable entrevistado en Biodôme:

> «[la concepción] es exponer la conexión entre el ser vivo y el ambiente. (…) Tenemos cuidados respecto a la calidad de vida de los organismos, como también con el público. (...) Biodôme participa de programas de conservación como el de la reproducción de los tití-león-dorados.»

El Jardín Botánico de FZB-BH colabora en la creación de políticas públicas y en el desarrollo de programas educativos y de investigaciones. Desarrolla estudios y acciones orientados a la conservación de la flora regional, señalándose los especímenes raros, endémicos y amenazados de extinción. Para la bióloga y educadora del sector de Educación Ambiental de FZB-BH, en entrevista hecha por la prensa, «los invernaderos educativos permiten la divulgación del conocimiento sobre la flora y sus relaciones con el ambiente y la fauna».[8]

De ese modo, se puede afirmar con base en la documentación y en los turnos de habla de los responsables por los espacios, que el Biodôme y la FZB-BH poseen, en su concepción, la intención de evidenciar los aspectos relativos a la conservación del medio ambiente, que determina una forma específica de tratar el tema de la biodiversidad en sus espacios expositivos. A continuación se describen y se analizan detalladamente los espacios seleccionados.

a. La Floresta Tropical de Biodôme

Presentar la «diversidad de la naturaleza, la fragilidad del medio ambiente del planeta Tierra y las maravillas del Cosmos» fueron las razones para la creación del Biodôme. Su finalidad fue la de reproducir, «bajo un techo de alta tecnología», algunos de los más importantes ecosistemas de América del Norte y América del Sur. Sin embargo, el gran «desafío está en crear y mantener bajo un mismo techo una variedad enorme de climas necesaria para sostener diferentes ecosistemas y para *simular estaciones del año 'reales' bajo luz y temperatura controlada*»[9] (destaque nuestra). Se trata de un lugar creado en el contexto de emergencia, en el ámbito social, de las cuestiones ambientales y de los efectos del desarrollo sobre la naturaleza (Crenn, 2003). Esos aspectos evidencian los objetivos que originaron ese lugar y las especificidades, tanto museográficas como relativas a la visión de biodiversidad, se imprimen allí y se expresan en su discurso expositivo.

Figuras 1 y 2
Detalles del comienzo de la exposición de la Floresta Tropical de Biodôme.

El sector designado para la Floresta Tropical es el primero que se visita en Biodôme. Al entrar ya se siente un denso aire caliente, impregnado de elevada humedad. Se trata de un invernadero con altura libre entre plantas, asociada a enormes árboles, vegetación rastrera, pequeñas cascadas y animales vivos. La luz del sol penetra por los cristales y su calor se retiene, mientras se liberan rocíos de agua de forma artificial entre los ejemplares. En el trayecto el visitante puede caminar observando los organismos existentes en ese ecosistema.

Una parte de las estructuras que componen el ambiente es artificial: troncos de cemento, hojas de plástico, etc., pero están totalmente disimuladas para los observadores menos atentos. Se destacan, de ese modo, los ejemplares vivos que, mezclados con modelos y réplicas, proporcionan al ambiente la idea de exuberancia de ese ecosistema.

En algunos espacios hay paneles con informaciones impresas acerca de los seres vivos, su ambiente, comportamientos, relaciones ecológicas, etc. Sobre ese tema, hay al comienzo un panel cuyo título es «La ley de la selva», que describe la competición entre organismos, pero también el papel de cada uno de ellos en el ambiente. Los textos describen también aspectos como la relación entre la conservación de la floresta y el efecto invernadero.

Figuras 3 y 4

Ejemplo de los aspectos descritos en la exposición de la Floresta Tropical: paneles con texto, ejemplares vivos, modelos (rocas) y separación en vidrio entre la senda y los recintos.

Entre árboles, paneles, caídas de agua y visitantes, se pueden encontrar animales libres, la mayoría aves. Los ejemplares que ofrecen algún riesgo al visitante o que pueden sufrir con un impacto del público se hallan en lugares más aislados, pero próximos a la senda por donde el visitante camina, separado solamente por rejas o fosos: es el caso de los capibaras, yacarés y del titi-león. No hay jaulas con rejas.

Algunos paneles presentan textos no sólo informativos, sino que incitan a la interacción física, cognitiva y afectiva del visitante, por ejemplo, asociando los alimentos a los diferentes tipos de aves, pidiendo atención a los sapos que están en peligro de extinción o permitiendo tocar estructuras anatómicas de algunos animales (uña de perezoso, por ejemplo).

Figura 5

Ejemplo de texto interactivo en el Biodôme. «¿Qué comen esos pájaros?»

Uno de los paneles enfoca la conservación de un primate brasileño en riesgo de extinción: el titi-león-dorado. Este menciona la participación del Biodôme, en cooperación con Brasil en el programa de protección de la especie y de su hábitat, amenazados por la urbanización y por la deforestación y comenta sobre la creación de una reserva propia para el manejo del animal.

Figura 6

Panel del titi-león dorado: mención a la participación del Biodôme en el programa de conservación internacional de los primates con sede en Brasil.

Otro panel ofrece información sobre pueblos de la floresta, su diversidad y su relación con el medio, indica tanto la fragilidad de ese ambiente como la de sus habitantes. Hay también un panel que advierte de la vulnerabilidad de ese ecosistema debido a prácticas agrícolas –quemada, caza indiscriminada, corte de maderas, etc.–. «También la floresta es un enorme banco genético que guarda más de la mitad de las especies de plantas y animales de la Tierra.»

Figura 7
Panel sobre la diversidad humana en la Amazonia.

Al final del recorrido, el visitante llega a un área diferente de la entrada y común entre los demás ecosistemas representados en el Biodôme y que podrá decidir por dónde seguir.

De ese modo, es posible afirmar que en Biodôme se asume enfáticamente el **abordaje conservacionista** al tratar de la temática de la biodiversidad. Es el caso del texto en el panel inicial de la exposición que refuerza la interdependencia entre los seres humanos y el medio ambiente y su perspectiva sobre la biodiversidad:

> «Durante millares de años, los indios de la Amazonia sobrevivieron en medio de la floresta tropical. El modo en que ellos usan la diversidad de las formas de vida a su alrededor es una expresión de su dependencia de la naturaleza, más que de su dominación. Ven a los seres humanos y sus instituciones como seres dependientes de la misma fuerza que controla el medio ambiente».

Este abordaje se puede identificar también con la presencia del emblemático titi-león dorado en la Floresta Tropical. El texto en las láminas próximas al recinto del titi-león dorado expone el trabajo conjunto de esa institución con otras internacionales para manejo y reproducción de esos animales, aspecto enfatizado también por el responsable entrevistado: «Participamos de programas de conservación tales como el de reproducción del titi-león dorado, el año del sapo, entre otros.

Un abordaje más de biodiversidad presente en esa exposición se refiere a los **niveles de organización** e involucra los niveles genético, de especie y de ecosistemas. Con relación al *nivel genético*, se observó una mención muy puntual solamente en la Floresta Tropical del Biodôme, cuando en el texto destacado en la figura 6 se afirma que la floresta es un «banco genético» que guarda «más de la mitad de las especies de plantas y animales de la Tierra».

Con relación al *nivel de especie,* se representa la diversidad taxonómica en la exposición, como se puede ver en el panel interactivo de la figura 5, que induce al público a descubrir los tipos de alimentos de diferentes aves. En ese panel, las aves se representan por su nombre popular y científico y se invita al visitante a identificar el tipo de alimento que se asocia a la letra correspondiente al alimento para la especie de ave. Como se ha indicado, hay diferentes tipos de organismos libres en el espacio de exposición, lo que refuerza la presencia del abordaje a nivel de especies expuestas.

Se trata especialmente del *nivel de ecosistemas* en esa exposición, en la medida en que se representan variados ecosistemas. En Biodôme, aunque nuestro estudio haya puesto énfasis en la Floresta Tropical, hemos visto que se tratan incluso otros ecosistemas más en el espacio expositivo, como la Floresta Laurentiana, el Ecosistema Marino de Saint-Lawrence, el Ártico y la Antártida. En la Floresta Tropical, se presentan los organismos en su hábitat y es posible visualizar en tiempo real los elementos bióticos y abióticos, como las lluvias, el aire caliente y la humedad alta.

No se observó el **abordaje evolutivo** en la Floresta Tropical del Biodôme, donde no hay mención a las relaciones de parentesco entre organismos; tampoco se trata de los contenidos dirigidos al desarrollo de poblaciones a lo largo del tiempo. Ese aspecto tampoco se destacó en la entrevista al responsable, que, sin embargo, nos llamó la atención de que lo más importante no es profundizar en los contenidos biológicos sino en los de conservación.

Se evidencia en Biodôme el **abordaje biogeográfico** en la medida en que la biodiversidad del lugar se sitúa, espacialmente, por medio de mapas de ubicación de esos ecosistemas en los diferentes continentes y de los ejemplares endémicos en sus regiones, como es el caso del panel del titi-león dorado en la figura 6.

Se presenta el **abordaje humano** en la Floresta Tropical del Biodôme principalmente en los paneles. Se muestra la diversidad de los pueblos y de las culturas de la Amazonia por medio de textos y de imágenes, como se puede ver en la figura 6. El ser humano es, en ese caso, uno más de los seres que viven en ese ambiente. Aun así es posible asegurar que el ser humano también figura en la exposición como visitante, como observador de esa naturaleza recreada, lo que suscita las cuestiones respecto de las relaciones entre el hombre y la naturaleza.

Como se ha apuntado, se han analizado los datos obtenidos frente a las categorías de museografía ambiental. Así, se buscó identificar las características de las museografías biocéntricas, ecocéntricas y antropocéntricas en la Floresta Tropical de Biodôme.

Se señala al principio que la creación de Biodôme, como lo indican Porcedda, Landry y Lepage (2006:287), ha ocurrido en el interior del movimiento ecológico y ecosistémico de los años 1990, con la finalidad de «haber integrado la noción de protección de la biodiversidad como se ha preconizado en Río en 1992». La exposición,

por medio de los paneles, presenta su participación en programas de conservación, en las que enfatiza la importancia de la protección de los organismos vivos. Además, la presencia de textos y de imágenes que tratan de los pueblos de las florestas demuestra la relevancia de abordar la manera en que esos grupos humanos se relacionan con los demás organismos vivientes en la floresta; incluso alegan, como demuestra el panel, que: «seres humanos y sus instituciones como seres dependientes de la misma fuerza que controla el medio ambiente».

Esos elementos que se apoyan fuertemente en la valoración de los seres vivos y en su conservación, y que se asocian al hecho de que la Floresta Tropical de Biodôme representa un ecosistema, remite a las características de la **museografía ecocéntrica**, ya que ésta tiene como foco presentar las relaciones entre organismos y de éstos con el medio ambiente, evocando las interacciones entre hombre y naturaleza. Más aún, la idea de inmersión asociada a las exposiciones refuerza la perspectiva museográfica, pues valora la representación del hábitat y de los ecosistemas, en el que Biodôme representa esta tendencia (Montpetit, 1996).

El panel que señala la vulnerabilidad de la Floresta Tropical debido a la quemada, caza indiscriminada y corte de maderas destaca algunos ejemplos de impacto ambiental causados por el ser humano. Además, la propuesta museográfica de la exposición, en la que recrea el ambiente donde el visitante –ser humano– es el observador y recorre el espacio contemplando los organismos vivos (o modelos), remite a la inevitable posición central del hombre en su relación con el mundo. Difícilmente sería diferente, al tratarse de un museo y, en ese sentido, se han identificado algunos elementos de la **museografía antropocéntrica** en este sitio.

La presentación de la identificación taxonómica de la mayoría de los organismos en los textos y la presencia de los ejemplares en la exposición demuestra la relevancia de los seres vivos y se identifican con la **museografía biocéntrica**. Sin embargo, la gran mayoría de los ejemplares están vivos en la exposición, lo que diferencia los naturalizados que marcaron esta perspectiva museográfica. Así, esa exposición muy poco se identifica con la museografía biocéntrica.

Si por un lado se identifican algunos aspectos relativos a las tres perspectivas museográficas que se han tenido como referencia, es importante resaltar que prevalece la museografía ecocéntrica, si se considera el conjunto analizado, que incluye tanto los principios conceptuales que fundamentan ese espacio, presentes en los documentos y en el discurso del responsable entrevistado, como el análisis de los textos y objetos de la exposición Floresta Tropical.

b. Los invernaderos temáticos de la Fundación Zoobotánica

En los documentos de la FZB-BH se puede notar claramente su misión: contribuir a la conservación de la naturaleza por medio de acciones de educación, investigación y ocio, que sensibilicen a las personas para el respeto a la vida. Los diferentes espacios del Jardín Botánico contribuyen a esa misión, entre ellos los invernaderos educativos. Ellos se ubican en un «escenario exuberante, con un sinnúmero de jardines y cuadro de plantas» y «atraen a los visitantes que desean descubrir las principales características de los ambientes de Minas Gerais, así como obtener informaciones para la investigación y desarrollo de actividades educacionales», lo que permite «la popularización del conocimiento sobre la flora y sus relaciones con el ambiente y la fauna». Se presentan los biomas de la Mata Atlántica, del Campo Rupestre y de la Caatinga, y también la historia evolutiva de las plantas y la diversificación del grupo de las Angiospermas (plantas con flores y frutos), «que posibilita a los visitantes tener acceso a las informaciones técnicas de una manera didáctica y aclaradora»[10].

En general los invernaderos son lugares parcialmente cerrados, con altura libre alta entre plantas, en donde se distribuyen los ejemplares botánicos vivos o en la forma de réplicas y modelos referentes a cada ambiente o tema. Hay también textos explicativos en paneles y etiquetas a lo largo del trayecto de visita. En algunas de ellas, existen escenarios montados que representan aspectos de la vida humana, así como escaparates con objetos de las culturas locales de los ambientes reproducidos. No existe reja entre la senda por donde se camina y el lugar donde se encuentran los objetos. En la mayoría de los invernaderos existe solamente un lugar para la entrada y para la salida, que hace único el recorrido de visita.

El invernadero del Campo Rupestre representa una región de lugares montañosos y rocosos. Los ejemplares de la vegetación local se encuentran en el suelo a lo largo del camino, con etiquetas donde constan los nombres de la familia y de la especie. En los paneles se dan otras informaciones, como la caracterización morfo-fisiológica del ambiente, los tipos de campos encontrados, con mapas y fotos que contextualizan las informaciones, además de la presentación de conceptos como endemismo y convergencia adaptativa, entre otros.

Figura 8
Invernadero del Campo Rupestre – FZB/BH.

Hay también, en la elección de algunos ejemplares y en los textos correspondientes, la intención de tratar aspectos de conservación, por ejemplo, al exponer la cuestión de la comercialización de las «siemprevivas» en tres diferentes paneles colgados en el espacio:

> Panel 1. «Siemprevivas. Las siemprevivas son así llamadas porque, aun después de recogidas y secadas, conservan la belleza por mucho tiempo. Por eso se las aprecia y se las comercializa.»
>
> Panel 2. «Cosecha. Su cosecha involucra la retirada de plantas enteras antes de que completen su ciclo reproductivo. Contribuye a que varias de ellas estén amenazadas de extinción.»
>
> Panel 3. «Conservación. Muchas personas sobreviven del trabajo con las siemprevivas. Por eso, se debe siempre proponer iniciativas que tengan como objetivo conciliar preservación y exploración comercial de la flora.»

Así, la presencia del abordaje conservacionista al tratar de la temática de la biodiversidad se identifica tanto al elegir la presentación del ejemplo de la siempreviva como en los textos informativos. Los paneles de las siemprevivas colgados en el invernadero del Campo Rupestre enfocan no sólo el impacto que esas plantas sufren por la recogida desordenada, sino también las acciones que se están emprendiendo para su conservación.

En otros paneles interactivos, donde el visitante puede obtener informaciones girando las láminas de metal con textos e imágenes, hay informaciones sobre aspectos biológicos y ecológicos de la vegetación y de los animales existentes en ese ambiente, que incluyen ejemplos de interacciones entre dichos organismos. Esas informaciones remiten al abordaje a **niveles de organización**, tanto de la especie, al identificar los especímenes existentes en paneles y etiquetas, como del nivel de ecosistema, al ejemplificar las interacciones entre organismos en el ambiente.

El invernadero de la Caatinga Mineira, cercana a la del Campo Rupestre, también posee ejemplares de ese bioma exclusivamente brasileño. En ese invernadero se presenta no sólo la vegetación característica de la Caatinga, sino también las costumbres, la cultura y el modo de vida de la población local.

La vegetación local también está representada en ese invernadero con etiquetas que dan informaciones taxonómicas sobre los organismos y refuerzan el abordaje a nivel de especie. Sin embargo el énfasis en ese caso está en la vida social de la población local, ya que en los escenarios de una casa y de puestos de venta de ferias y en los escaparates se plantean temas tales como modo de vida, minería, irrigación, quemadas, y se incluyen textos con declaraciones de personas sobre el cotidiano de la sequía.

En ese sentido, se evidencia el **abordaje humano** y, en el caso de los invernaderos de la FZB, el ser humano aparece de formas variadas. En el invernadero del Campo Rupestre, él tanto es responsable del impacto ambiental, como posee el potencial de revertir ese cuadro, cuando sepa explorar «comercialmente» el ambiente, ya que también necesita los recursos ofrecidos por el medio. En el invernadero de la Caatinga, se enfatiza el enfoque cultural del abordaje humano de la biodiversidad, en la medida en que el ser humano aparece como uno de los seres que vive en ese ambiente, que utiliza los recursos, pero también interactúa con los demás seres vivos y con los elementos abióticos allí existentes.

Figuras 9 y 10
Invernadero de la Caatinga: trayecto interno y detalle de escaparate con panel sobre la artesanía local.

Figuras 11 y 12
Detalles del invernadero de la Evolución: escenarios, diseños y modelos que representan organismos de las variadas eras geológicas.

Más que eso, el ser humano también sufre el impacto de los cambios de ese ambiente en una íntima relación con los demás organismos que allí viven. Se presentan todos esos aspectos por medio de los textos y de los objetos, como la reconstrucción de una vivienda local, de ejemplos en escaparates de la artesanía de la región y de la reconstrucción de los puestos de venta de las ferias, donde se revela la temporalidad de los productos naturales extraídos del ambiente.

Se explora bastante el **abordaje biogeográfico** en los invernaderos de FZB en la medida en que existen mapas de los biomas tratados que tratan de ayudar al visitante a ubicarlos en el estado de Minas Gerais. Especialmente en los invernaderos del Campo Rupestre y de la Caatinga se indican no sólo las regiones donde se encuentran esos biomas, sino también los lugares en donde se pueden encontrar los ejemplares, con la descripción de las características del paisaje, los aspectos físicos, geológicos y climáticos.

El invernadero de la Mata Atlántica es una de los más amplios y presenta ejemplares vivos de ese bioma. En ella prácticamente no hay paneles con informaciones sobre ambiente o sobre los ejemplares. Algunas de las plantas poseen identificación taxonómica en forma de pequeñas láminas, semejantes a las que aparecen en los demás invernaderos, enfatizando el abordaje a niveles de organización, especialmente el de especie.

Se trata el tema de la Evolución en un complejo formado por dos invernaderos y por las Plazas del Fósil y de la Fuente. Se plantea la temática bajo dos perspectivas: la de la historia evolutiva de las plantas y la del éxito de las flores: «El primer invernadero engloba desde los vestigios de vida en el planeta a partir de las evidencias fósiles hasta las plantas y otros seres actuales. La segunda presenta el grupo de las Angiospermas, compuesto por vegetales que mejor se adaptaron y se diversificaron a lo largo de todo este tiempo»[11]. Al final de la exposición, se destacan algunos ejemplos de amenazas provocadas por las acciones del ser humano, como las quemadas, las deforestaciones, la erosión y la introducción de plantas invasoras.

El invernadero de la Evolución, por el propio tema tratado, se diferencia bastante de los demás en la medida en que no pretende presentar un bioma específico, sino la historia evolutiva de las plantas y de los demás organismos y del propio ambiente físico. Los textos en etiquetas identifican los ejemplares, formados por modelos y ejemplares de vegetales vivos y en los paneles colgados se explican las eras geológicas. En el trayecto de ese invernadero existen ejemplares de vegetación correspondientes a las determinadas eras geológicas, y se busca asociarlas a los demás organismos existentes en los diferentes períodos. Al final hay una cueva en cuyas paredes existen representaciones de pinturas rupestres. Así que, a partir del desafío de presentar el concepto de evolución tanto en la escala geológica como biológica, y, en especial, usar las plantas para tratar la historia evolutiva de esos organismos y la diversificación de uno de sus grupos, el de las Angiospermas, la FZB revela la preocupación en abordar la biodiversidad en el **abordaje evolutivo**.

Se señala que en los invernaderos de la FZB no se identificó el nivel genético del abordaje en los niveles de organización de forma explícita en los textos, tampoco en los objetos expuestos. Respecto del nivel del ecosistema, cada invernadero, con excepción del que trata del tema Evolución, se refiere a un ambiente diferente para evidenciar así la diversidad de ecosistemas y biomas. Sin embargo, la cuestión de la identificación taxonómica está mucho más presente en los invernaderos de la FZB que en Biodôme, como se pudo ver en las láminas y etiquetas de prácticamente todos los ejemplares expuestos. En el invernadero sobre Evolución también aparece el **abordaje humano** de forma distinta, ya que en la cueva reconstruida existen pinturas rupestres que remiten al surgimiento del ser humano en un momento de la historia de los organismos.

En lo que se refiere al análisis de la museografía ambiental de los invernaderos, como el de Campo Rupestre y de

Caatinga, se evidencian los elementos antropocéntricos. Un ejemplo es el caso de las siemprevivas de Campo Rupestre, amenazadas de extinción, cuando se sugiere, en el texto, acciones humanas para su conservación, lo que indica también una perspectiva sostenible al citarse la importancia de que «… se propongan iniciativas que tengan como objetivo conciliar la preservación y la exploración comercial de la flora». En Caatinga se percibe el foco en la comunidad local, demostrándose por medio de escenarios, objetos y textos, su modo de vida y su relación directa con el medio ambiente y la influencia de los aspectos biogeográficos y climáticos en el cotidiano de la población. En los dos casos, las exposiciones evocan los problemas ambientales y afectan directamente al ser humano y ofrecen un espacio/tiempo de reflexión sobre el impacto de acciones antrópicas sobre el medio ambiente y al revés.

Por otro lado, el invernadero Campo Rupestre en los demás elementos museográficos en conjunto con el invernadero Mata Atlántica, al presentar la reconstrucción del ambiente con algunos de sus ejemplares vegetales identificados solamente por etiqueta, se remiten a la museografía ecocéntrica. Ésa, como hemos visto, se centra en la representación de los ecosistemas y en las relaciones entre los seres vivos y de ésos con el ambiente. En ese caso, se identifican elementos muy semejantes a los dioramas característicos del siglo XIX, preocupados, de acuerdo con Van-Präet (1995), en museografiar la naturaleza y poner en escena los aspectos ecológicos.

La idea de exposiciones temáticas puede asociarse al invernadero de Evolución. Si por un lado ese espacio no tiene como tema los ecosistemas, que es característica de los museos de historia natural del mismo período, por otro se realiza un recorte temático al enfocar la historia evolutiva de las plantas y busca representarlo con la finalidad de aclarar al público los conocimientos allí contenidos. La disociación entre colección y exposición y la organización de exposiciones temáticas, como indica Van-Präet (ibíd.), obtuvo aliento a mediados del siglo XIX, exactamente al acentuarse la preocupación por la comprensión del público sobre las exposiciones. El invernadero de Evolución puede, entonces, identificarse con una tendencia que se instaura en ese período y que se refuerza, desde el siglo XX, al volverse el público elemento central del proceso educativo y comunicativo de los museos. Esta perspectiva didáctica está presente en los documentos de FZB y se ha reforzado por el responsable entrevistado al relatar las acciones educativas de esa institución.

Elementos de la museografía biocéntrica, con el énfasis puesto en los especímenes y en su identificación taxonómica, se evidencian en la presentación de los ejemplares de vegetales expuestos a lo largo de todos los invernaderos. Se señala que, ya que FZB es una institución también de investigación en el área biológica, la identificación de los especímenes es extremadamente valorada en su discurso expositivo. Se debe asimismo resaltar que la presencia de la identificación taxonómica de especímenes, de por sí, no debe caracterizar una exposición como biocéntrica. En el caso de FZB, al analizarse su propuesta conceptual, a partir de la documentación disponible y al considerarse los elementos museográficos que se han analizado, aseguramos que los invernaderos se identifican mucho más con las museografías antropocéntricas y ecocéntricas.

V. CONSIDERACIONES FINALES

Hemos visto en el análisis que, si por un lado, básicamente todos los abordajes de biodiversidad están presentes, en mayor o menor grado, en las exposiciones, por otro, hay, en las especificidades de cada abordaje, aspectos más o menos enfatizados en cada una de ellas. Por ejemplo, el abordaje en el nivel de organización genético está ausente en los invernaderos de FZB y poco presente en Biodôme. El abordaje evolutivo se evidenció solamente en el invernadero dedicado a ese tema en FZB pero no aparece en Biodôme. Sin embargo, se identificó un fuerte énfasis en el abordaje conservacionista en ambas.

También se identificaron elementos de las tres modalidades de museografía en las dos exposiciones; sin embargo, hay un evidente énfasis por la museografía ecocéntrica en la Floresta Tropical de Biodôme, que ya se ha identificado por otros autores (Porcedda, Landry y Lepage, 2006). En el caso de los invernaderos de FZB, se identifica la fuerte presencia de elementos tanto de la museografía ecocéntrica como de la antropocéntrica. El invernadero de Caatinga y el tratamiento dado en el caso de la conservación de las siemprevivas en el invernadero Campo Rupestre remiten a la museografía antropocéntrica al abordar los problemas ambientales que afectan al ser humano. Ya los demás elementos expositivos de Campo Rupestre, de Mata Atlántica y de Evolución se han considerado fuertemente vinculados a las características ecocéntricas.

Esos datos suscitan reflexiones importantes sobre cómo se presenta la biodiversidad en exposiciones inmersivas de museos. Los lugares aquí analizados poseen especificidades respecto de la museografía, con la intención explícita de promover una experiencia sensorial, cognitiva y emocional. En ese sentido, los diversos abordajes de biodiversidad identificados parecen proporcionar algunos de los contenidos fundamentales para que esa experiencia pueda realmente hacerse efectiva en la exposición. En la medida en que se enfoca la perspectiva de la conservación, como también se tratan los aspectos sobre la biología, la sistemática, la taxonomía, la evolución y la biogeografía, se puede profundizar la experiencia de visita en la dimensión cognitiva. En ese aspecto, Montpetit (1996:56) llama la atención sobre el hecho de que los dioramas y las exposiciones de inmersión, como la de Biodôme, manifiestan la clara intención de los museos de usar las colecciones para llevar información a los visitantes «ordinarios», con pocos conocimientos previos.

Sin embargo, las exposiciones inmersivas que se han estudiado también movilizan, en su museografía, aspectos sensoriales y emocionales, ya que llevan a ese ambiente controlado el simulacro de las experiencias de una visita en el ambiente natural real: los olores, los sonidos, las visiones. En ese aspecto, se observa la dificultad de presentar en estas exposiciones ciertos fenómenos biológicos,

como la dimensión «invisible» de la genética o del tiempo profundo de evolución. Esa dificultad ya se ha identificado en la literatura en exposiciones que plantean temáticas biológicas (Girault y Guichard, 2000). Marandino y Mônaco (2009) indican que el abordaje conservacionista no es el centro de las exposiciones de dos museos brasileños estudiados, que son un zoológico y un museo de zoología. Así, es posible evidenciar una cierta vocación de las exposiciones inmersivas en presentaciones que poseen la ecología y la conservación como centro.

Nos hacen reflexionar esos datos sobre qué tipo de imagen de la naturaleza proponen las exposiciones inmersivas. En las dos exposiciones que se han estudiado aquí, al reconstruirse biomas y ecosistemas en ambiente controlado con organismos vivos «reales», se enfatizan abordajes ecocéntricos. Existe, así, una coherencia entre la propuesta conceptual científica relativa al tema de la biodiversidad y la propuesta conceptual museográfica que se señala, por medio de textos y objetos, en las relaciones ecológicas. Se nota, en menor grado, las intenciones de demostrarle al público los elementos propios de la museografía antropocéntrica, que evidencian los problemas ambientales. La museografía biocéntrica, a su vez, parece incluso no tener más lugar en las exposiciones contemporáneas en las que las cuestiones de conservación y de impacto ambiental se volvieron centrales. De ellas permanece la identificación taxonómica de los ejemplares.

El ser humano figura en las exposiciones de variadas maneras. Sin embargo, en los museos que se han estudiado, el público se convierte en un observador que contempla la naturaleza *recreada por él mismo* y se le propone conservarla. Al convertirla en bien común, patrimonio natural, lugar que se debe estudiar y preservar por medio de acciones científicas, culturales, sociales y políticas, se busca establecer una determinada relación hombre-naturaleza, en la que el ser humano es el centro generador de cambios y de control del mundo circundante. El papel educativo de esos espacios se empieza a cuestionar en la medida en que se pueden convertir en sitios en los que se refuerzan la centralidad del ser humano en la relación con el medio ambiente. Desde el punto de vista ambiental, ¿es ése el mensaje que queremos transmitir? ¿Cuáles son las acciones que los museos, por medio de sus exposiciones, quieren estimular? ¿Cuáles son las exposiciones más adecuadas para que se promueva un cambio de actitud del ser humano respecto de la naturaleza: ecocéntricas o antropocéntricas? Tales cuestionamientos revelan, por un lado, la importancia de analizar los mensajes educativos transmitidos por los museos. Por otro lado, se señalan tensiones en la construcción del discurso expositivo de los museos, ya que encierran controversias tanto científicas como sociales sobre el tema de la biodiversidad, poniendo así de relieve el papel educativo y contemporáneo de esas instituciones (Mazda, 2004; Pedretti, 2004).

Crenn (2003) discute el proceso de creación del Biodôme en Canadá, espacio que aquí se analizó, y propone importantes cuestiones sobre el tema de la adquisición del patrimonio del medio ambiente. En líneas generales el autor revela las controversias sociales y políticas en la creación de este museo sobre la determinación de *qué es y a quién pertenece* el patrimonio ambiental. Por ejemplo, ¿el titi-león brasileño que vive en la Floresta Tropical de Biodôme es patrimonio de Montreal, de Canadá, de Brasil o del mundo? El análisis propuesto por este autor nos hace reflexionar sobre los procesos de creación de lugares dirigidos hacia la educación, como los museos, al elegir como tema central el ambiente y la biodiversidad. Al exponer esos contenidos y estimular al público a reflexionar sobre la relación entre ser humano y naturaleza, ¿qué representaciones se están construyendo y qué actitudes se están estimulando? Este artículo, a partir del análisis sobre los abordajes de biodiversidad y sobre la museografía ambiental de las exposiciones estudiadas, pretende contribuir a la profundización de esas cuestiones.

NOTAS

1. Disponible en: <http://canadianbiodiversity.mcgill.ca/english/index.htm>. Accedido el: 27/05/2010.
2. La Convención sobre Diversidad Biológica (CDB) ha sido firmada por 175 países y ratificada por 168 de ellos, entre los cuales Brasil (BRASIL, 2000). El alcance de la CDB va más allá de la conservación y utilización sostenible de diversidad biológica. Abarca, también, el acceso a los recursos genéticos, cuyo objetivo es la repartición justa y equitativa de los beneficios generados por su uso, lo que incluye la biotecnología.
3. Intergovernmental Panel on Climate Change (Disponible en: <http://www.ipcc.ch>. Accedido el: 27/05/2010).
4. Montpetit (1996) hace referencia directa al Biodôme, en Montreal/Canadá, museo estudiado en este trabajo, como ejemplo de una exposición de inmersión.
5. Los objetos y los textos son dos elementos que definen la especificidad educativa de las exposiciones de museos (Van-Präet y Poucet, 1992) y por eso se los eligieron como foco para análisis de esos lugares.
6. El término diorama tiene su origen en la lengua griega en la que *dia* significa «a través» y «*horama*» significa «para ver». Las definiciones actuales de diorama lo aproximan a la idea de representación (Asensio y Pol, 1996). Son, de ese modo, objetos comunes en los museos, verdaderos escenarios que representan ambientes naturales, entre otros temas.
7. Disponible en <http://www2.ville.montreal.qc.ca/biodome/site/presse/pdf/dossierPresse_en.pdf>. Accedido el:27/05/2010.
8. Informaciones obtenidas en el artículo «Estufas educativas promovem o conhecimento sobre a flora e suas relações com o ambiente e a fauna». Disponible en <http://portalpbh.pbh.gov.br/pbh/ecp/noticia.do?evento=portlet&pAc=not&idConteudo=26062&pIdPlc=&app=salanoticias>. Publicado en 31/12/2008 10:45:56. Accedido el: 23/01/2010.
9. Datos obtenidos en la publicación Botanical Garden, Insectarium, Biodôme and Planetarium – Montreal. Lês Messagerie de presse Benjamin Inc., Québec, 1999.
10. Informaciones obtenidas en el artículo «Estufas educativas promovem o conhecimento sobre a flora e suas relações com o ambiente e a fauna». Disponible en <http://portalpbh.pbh.gov.br/pbh/ecp/noticia.do?evento=portlet&pAc=not&idConteudo=26062&pIdPlc=&app=salanoticias>. Publicado en 31/12/2008 10:45:56. Accedido el: 15/01/2009.
11. Informaciones obtenidas en el artículo «Estufas educativas promovem o conhecimento sobre a flora e suas relações com o ambiente e a fauna». Disponible en: <http://portalpbh.pbh.gov.br/pbh/ecp/noticia.do?evento=portlet&pAc=not&idConteudo=26062&pIdPlc=&app=salanoticias>. Publicado en 31/12/2008 10:45:56. Accedido el: 15/01/2009.

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Biodiversity in immersion exhibitions in science museums: implications for museum education

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Summary

This article examines the ways in which biodiversity is presented in two immersive exhibitions of science museums. It intends to discuss the importance of the analysis of the role of museums in the advertising and education of biodiversity issues. The learning and teaching of the biodiversity concept looks apparently easy; however, the term is polysemic and its understanding is an important step for the education of biodiversity, involving a network of information, ideas and concepts in the scope of science as well as in the ways it has been appropriated by society. By considering the different influences the term biodiversity receives for its conceptualizations, many are the challenges referring to education on this issue. Especially in relation to museums, the diversity of living organisms has always been present in these places, either in collections and investigations, or in exhibitions and educational actions. Throughout the years, the way of presenting the organisms has been transformed due to changes in the conceptions of science, museography, communication and education. Many exhibitions found in Natural History museums, botanical gardens and zoos have approached biological diversity and/or the environmental problems. There is, however, a new way of conceiving exhibitions in the area of natural sciences that is more similar to botanical gardens and zoos in the form of exhibiting live organisms: the immersion exhibitions. Those exhibitions search to reproduce the environments in which these organisms live in the most realistic way, with the intention of providing a total immersion for the visitors of these places, as if they were actually visiting the real environment. By representing the biomes, the ecosystems or the habitats of these organisms and mixing them with live animals, replicas and models, they create an affectively stimulating environment and the public can experience the sensations they would usually feel only in nature. This article presents the analysis of the immersive exhibitions in two different museums: one is Canadian and the other Brazilian, so it can research the speech about biodiversity presented in these places and the educational implications for its visitors. The first museum is the Biodôme, located in Montreal/Canada, and the second is the Zoo Botanical Foundation located in Belo Horizonte/Brazil. The data collected were analyzed to characterize the approaches in biodiversity and environmental museography in these exhibitions.

The research methodology was qualitative and it tried to adapt the characteristics of this kind of research for the spaces of museums, given the importance of knowing the way the production of immersive exhibitions works in order to understand the perspective of biodiversity they emphasize. The texts and objects of the exhibitions were analyzed, for being considered as the elements that define the pedagogic specificity of these spaces. The procedures were: observation of the exhibitions, documental analysis and interviews. The final analysis was done based on the dialogue between the collected data and the categories proposed on the approaches of biodiversity and environmental museography.

The theoretical framework deepened in the concept of biodiversity and environmental museography. The categories of analysis on the approaches of biodiversity were built based on the works of authors who discuss both the concept of biodiversity in academic environment, as the study of biodiversity in educational and communication contexts. Based on these categories, the first analysis of the exhibitions was done. In the second stage, the museographic aspects were analyzed based on the direct relationship on environmental issues.

We identified the presence of almost all approaches to biodiversity in both exhibitions, with special attention to the conservational one; the evolutionary approach was found only in FZB. We also verified that the environmental museography of the exhibitions is more ecocentric then anthropocentric and even less biocentric.

The educational implications of these results were discussed, trying to analyze the educational role of the science museums. The main fact is that the figure of the human being in the exhibitions is presented in many different ways. In these exhibitions the public is converted into an observer who contemplates nature *recreated by themselves,* proposing to conserve it. By converting nature into a common good, a natural patrimony, a place that must be studied and preserved trough scientific, cultural, social and political actions, a certain relationship man-nature is established, in which the human being is the generating center of exchanges and control of the surrounding world. Such aspects reveal, on the one hand, the importance of analyzing the educational messages conveyed by the museums. On the other hand, some tensions are signed in the construction of the exhibition speech of the museums, once they comprise both scientific and social controversies on the issue of biodiversity, therefore emphasizing the educational and contemporary role of these institutions.

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DIMENSIÓN POLITICA DE LA POPULARIZACIÓN DE LA CYT EN AMERICA LATINA: ESTUDIO DEL CASO BRASILEÑO

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Introducción

Entidades nacionales de ciencia y tecnología (CyT) de diversos países latinoamericanos se han visto caracterizadas, en las últimas décadas, por la presencia de un "discurso emergente" que busca promover nuevas relaciones entre ciencia, tecnología y sociedad y que se contextualiza en el ámbito de la popularización de la ciencia. Este discurso ha ido permeando, cada vez más, los documentos oficiales de CyT de los gobiernos (Godin y Gingras, 2001; Irwin, 2006; Lozano, 2005; Navas, 2008) y es elaborado a partir de construcciones históricas e institucionales que han permitido la formulación de acciones, estrategias, programas nacionales y multinacionales, y propuestas de políticas públicas sobre el tema.

La movilización emprendida por los gobiernos y la inclusión de temas como popularización de la CyT o divulgación científica en la agenda política, nos remite a un cambio en el papel del Estado, que asume, al legitimar estas áreas, un nuevo contrato social. En este contexto, vemos que los argumentos para incluir la popularización de la CYT en la agenda política, varían de país en país, considerando desde objetivos generales, asociados a la educación en ciencias y tecnología, hasta compromisos específicos relacionados con la inclusión social,

la compresión y el uso de la CyT, la promoción y valoración de la CyT, la divulgación de resultados de investigaciones desarrolladas en el área y el establecimiento de conexiones con los sectores científicos, académicos (Lozano, 2005) y demás sectores sociales.

Diversas iniciativas han sido promovidas en America Latina para articular acciones estratégicas. En esa perspectiva encontramos la Red de Popularización de la Ciencia y Tecnología de América Latina y el Caribe (Red-POP), creada por la UNESCO en 1990, para viabilizar el intercambio de experiencias e informaciones relacionadas con popularización de la CyT. El objetivo general de esta organización, descrito en sus estatutos, es "contruibuir para el fortalecimiento, intercambio y activa cooperación entre los centros y programas de popularización de la ciencia y de la tecnología en América Latina y el Caribe" (www.redpop.org). Este objetivo general se desdobla en objetivos específicos que han caracterizado, también, el trabajo de otros organismos internacionales como la Organización de Estados Americanos.

Entre las actividades de la Red-POP se encuentran: la identificación de programas y proyectos en el área de popularización de la CyT, que se desarrollen por medio de cooperación regional; la divulgación de proyectos existentes en esferas nacionales y regionales para la toma de decisiones conjuntas; la mejoría de la calidad de centros y programas de popularización de CyT; el estudio de problemas identificados y la búsqueda por soluciones que se apoyen en las infraestructuras existentes de los diversos países. Las iniciativas desarrolladas son financiadas por medio de contribuciones de los centros y programas miembros, de organismos nacionales, regionales e internacionales y de entidades públicas y privadas.

Sumado a los esfuerzos de la Red-POP y manteniendo una visión internacional, la Organización de Estados Americanos (OEA) ha promovido el desarrollo de debates sobre el tema de la popularización de la CyT, que buscan dirigir programas específicos para la integración de estrategias de acción de vários paises. De esa forma encontramos el proyecto *Iniciativa Hemisférica sobre Popularización de la Ciencia*, en el que participaron todos los países

latinoamericanos y que estuvo bajo coordinación del *Ministerio da Ciência e Tecnologia* de Brasil. Esta propuesta surgió como resultado del *Taller sobre Popularización de la Ciencia y Tecnología*, realizado en 2004, en Rio de Janeiro, como parte del *Proyecto de Cooperación Hemisférica y Desarrollo de Política Científica y Tecnológica*, implementado por la OEA.

Entre los objetivos de la mencionada iniciativa hemisférica se encuentran (OEA, 2009):

> *Conceptualiar modelos para la popularización de la ciencia, de acuerdo con las necesidades nacionales y regionales, que permitan la apropiación de la ciencia por la poblaciones para mejorar la calidad de vida y conseguir el desarrollo sostenible y eqüitativo; ampliar la integración y la cooperación científica entre los países de las Américas; capacitar a los profesionales que trabajan con divulgación científica; producir material de apoyo para los rerefidos profesionales y conocer la opinión y la percepción de la población sobre la ciencia y tecnología.*

Otro ejemplo de instituciones articuladoras en América Latina, es el Convenio Andrés Bello (CAB), una organización que ha buscado, recientemente y por medio de procesos deliberativos, la formulación e implementación de una política regional de apropiación de la ciencia, la tecnología y la inovación (CAB, 2009). La misma propende por un cambio de percepción latinoamericano de políticas e iniciativas separadas hacia una política pública regional, articulada por los 13 países signatarios del CAB (Argentina, Bolivia, Chile, Colombia, Cuba, Ecuador, España, México, Panamá, Paraguay, Perú, República Dominicana y Venezuela).

A nivel de esfuerzos nacionales de diferentes paises latinoamericanos, las intenciones de los gobiernos en relación al tema de la popularización de la CyT se han manifestado por medio de acciones específicas, que difieren de un país a otro, como veremos en los ejemplos a seguir.

En el *Foro de Acción Permanente Sobre Popularización y Enseñanza de la Ciencia y la Tecnología* (2005) organizado por el CAB y el Ministerio de Ciencia

y Tecnología de Venezuela, representantes de los órganos nacionales de CyT de diferentes países latinomericanos fueron convocados para presentar la dimensión que estas áreas habían alcanzado en la agenda política. En dicho evento Gustavo Rodriguez, entonces Viceministro de Educación Superior, Ciencia y Tecnología de Bolivia presentó, dentro del *Plan Nacional de Ciencia y Tecnología* 2004-2007, el *Programa Horizontal de Difusión y Popularización de la Ciencia y la Tecnología* que proponía, dentros de sus objetivos y directrices de acción, el fomento de la divulgación del conocimiento científico y tecnológico en el país (Pavillán, 2005).

En Venezuela, el poder público reconoce, en el artículo 110 de la Carta Magna (Marcano, 2004), *"el interes público de la ciencia y la tecnología como uno de los instrumentos fundamentales para el desarrollo enconómico, social y político del país, así como para seguridad y soberanía nacional"*. En el ámbito gubernamental, las acciones de populariación de CyT se encuentran articuladas por medio del Ministerio del Poder Popular para la Ciencia y Tecnología y de las Fundaciones de Ciencia y Tecnología (Fundacites), organos adscritos a dicho Ministerio. Actualmente Venezuela cuenta con más de 10 Fundacites que presentan, dentro de su misión, objetivos relacionados con la popularización y divulgación de la CyT y asociados a proyectos estratégicos.

En la perspectiva de programas nacionales consolidados, Chile implementa, desde 2005, un Programa Nacional de Divulgación y Valoración de la Ciencia y Tecnología, el programa EXPLORA, creado por el Consejo Nacional de Ciencia y Tecnología (CONICYT) con el objetivo de contribuir para la creación de una cultura científica y tecnológica en la comunidad. Este programa está presente en todo el país por medio de coordinaciones regionales que articulan diversas acciones como la Semana Nacional de CyT, ferias de ciencia y congresos (CONICYT, 2009).

En el I*II Foro Conciencia Abierta* realizado en el 2008 en la ciudad de Bogotá, el Consejo Nacional de CyT de Colombia presentó el documento oficial *Política de Apropiación Social de la Ciencia, la Tecnología y la Innovación*, una iniciativa gubernamental que busca *"convocar y movilizar a los agentes de la Ciencia, la*

Tecnología y la Innovación, incluyendo la sociedad colombiana en general, para que participen activamente en los procesos de Apropiación Social" (CNCyT, 2008). El referido documento reúne aspectos teóricos relacionados con el tema de la apropiación social de la CyT, actores relacionados, líneas de acción detalladas e impactos esperados a partir de la implementación de esta política.

Como parte de los esfuerzos nacionales por impulsar actividades de popularización de la CyT es importante citar, también, la iniciativa privada. En el caso de Brasil, por ejemplo, cabe hacer referencia a Vitae, una entidad que, por casi dos décadas, cumplió el papel de um órgano nacional de CyT, dando soporte finaciero estable para museos y centros de ciencias en el país (Navas, 2008).

Los ejemplos referidos reunen inciativas de diferente naturaleza que van desde intenciones y objetivos de acción, hasta programas nacionales consolidados, que articulan diversos actores sociales. Estos ejemplos sumados a las iniciativas de otros países por definir programas nacionales de divulgación científica y de popularización de la CYT, ilustran um proceso común de mobilización que busca articular, por medio de contratos sociales legitimados, acciones a largo plazo que puedan establecer relaciones sostenibles entre la ciencia y la sociedad.

Surgen, en este punto, algunas cuestiones interesantes que podrían ser colocadas.

Como son construídos los dicursos políticos alrededor del tema de la popularización de la CyT? Que aspectos históricos e institucionales están relacionados? Que concepciones de popularización de CyT son privilegiadas en esos discursos? Que modelos de comunicación pública da la CyT sustentan la acciones implementadas?

Para aproximarnos de estos interrogantes presentamos, a seguir, un estudio de caso realizado en Brasil a partir de la gestión del gobierno vigente entre 2003 y 2006, en la que el discurso sobre popularización de la CyT emergió por medio de manifestaciones explícitas del gobierno y acciones implementadas. Este estudio está contextualizado dentro de una investigación cualitativa y apoyada

en datos descriptivos, obtenidos por medio de análisis de documentos oficiales del Ministerio de Ciencia y Tecnología (MCT) de Brasil y entrevistas con representantes del gobierno (Navas, 2008).

Legitimación política del área de popularización de la CyT en Brasil

Como en el caso de otros países de America Latina y a la luz de documentos oficiales analizados, vemos que la divulgación científica se transformó, en Brasil, en una dimensión del discuso político (Navas, 2008). Este proceso se inició, como destacado por Moreira (2005), con el propio histórico de actividades de divulgación científica, lo que llevó a una legitimación e institucionalización política del área. Esas mismas consideraciones son expuestas por un miembro del *Comitê Temático de Divulgação Científica* del CNPq (Conselho Nacional de Pesquisa), entrevistado durante la investigación realizada:

> *Entonces la divulgación científica se enmarca en ese proceso histórico de crecimiento de la ciencia, crecimiento de la divulgación científica porque creció la ciencia, crecimiento del entendimento... de la percpeción social sobre la importancia de la ciencia y esos tres ejes van a interactuar para propiciar la creación de esos instrumentos del gobierno en los vários ministerios, [...] y en la propia sociedad. Y, con eso, el Ministerio, estando convencido de esa perspectiva en relación a la divulgación [...] comenzó a institucionalizarla, a tomar iniciativas institucionales y ahi vino todo... la creación del Departamento* [de Difusión y Popularización de la CyT] *del MCT, el financiamiento de actividades específicas de divulgación científica, la creación de comites y así en adelante...*

El crecimiento del área de divulgación, claramento expuesto por el entrevistado, impulsó al gobierno a articular iniciativas existentes y crear, al mismo tiempo, condiciones propicias para el desarrollo de nuevos programas y proyectos. En ese contexto, la creación de un Departamento de Difusión y Popularización de la CyT (DEPDI), vinculado a la Secretaría de Inclusión Social del MCT, nos muestra cambios en las prácticas del gobierno, reflejadas en una institución específicamente creada para administrar, promover y desarrollar actividades de divulgación científica.

Desde su origen, en 2003, y hasta el 2006, el DEPDI mobilizó varias acciones de popularización de la CyT , entre ellas: 1) dos convocatorias para financiamiento de proyectos en al área de popularización de la CyT, (2) desarrollo de programas nacionales de divulgación científica, como la Semana Nacional de CYT y el programa Ciencia Móvel de museos itinerantes (MCT, 2007) (3) la creación de un *Comitê Temático de Divulgação Científica* dentro del *Conselho Nacional de Pesquisa*, vinculado al MCT y (4) la presentación de una primera versión de la Política Pública para Popularización de la CyT (Moreira, 2005).

En busca de categorías de análisis para las actividades de popularización de la CyT

El análisis propuesto para el caso brasileño usa como marco los modelos de comunicación pública de la ciencia descritos por Lewenstein (2003) y Lewenstein & Brossard (2006), aplicables a diferentes dimensiones y objetos de estudio, entre ellos, acciones gubernamentales de popularización de la CyT. En este caso tomamos como referncia dos grandes modelos descritos: (1) el modelo de déficit, aplicable a actividades unidireccionales, que buscan, apenas, transmitir información a grandes públicos y (2) el modelo participativo, aplicable a actividades bidireccionales, que buscan establecer un verdadero diálogo entre la ciencia y la sociedad, rescatando conocimientos locales y tradicionales.

De esta forma, los datos colectados por medio de documentos oficiales y de las entrevistas realizadas, así como la profundización teórica en los temas de referencia para esta investigación, contextualizados en el área de Estudios Sociales sobre Ciencia, nos permitieron identificar dos categorias en las que transitan las actividades de popularización del Ministerio de Ciencia y Tecnología del Brasil:

- ***Actividades informativas*:** consideran procesos y acciones que (1) buscan diseminar información sobre CyT en amplios sectores de la sociedad, (2) tienden a considerar la ciencia como un cuerpo de conocimientos dado, y un conjunto de eventos neutros que puede ser

transmitidos desde los especialistas hasta el público y (3) tienden a considerar al público como lego en asuntos de CyT y, en consecuencia, como actor pasivo y como un único grupo com características homogêneas.

- ***Actividades dialógicas:*** consideran procesos y acciones que (1) buscan una negociación de conocimientos entre el público, los científicos y otros agentes relacionados a la CyT (2) tienden a considerar la ciencia en una perspetiva dinámica y humana (3) consideran al público como actor activo, con características heterogeneas, con conocimientos previos sobre CyT (y sobre otras áreas relevantes para la solución de problemas reales), con derecho y capacidad de ser críticos y de participar en procesos de toma de decisió .

Presentamos, a seguir, el análisis realizado sobre las actividades de popularización empreendidas por el Ministerio de CyT de Brasil, a partir de las categorias propuestas.

Actividades de popularización de CyT del gobierno brasileño

En diferentes documentos gubernamentales analizados, como el Plan Plurianual (MCT, 2003), las convocatorias para financiamento de proyectos de popularización de CyT de 2003 y 2006 (CNPq, 2009) y la primera versión de Política Pública para Popularización de la CyT (Moreira, 2005), fue posible identificar actividades informativas.

Este tipo de práctica aparece, comunmente asociada a los medios masivos de comunicación (tv, radio, internet), a la informatización de ambientes como bilbiotecas, laboratórios y acervos, a la producción de material e información sobre ciencia y a la difusión de la producción nacional en CyT. Algunos ejemplos puntuales pueden ser destacados a partir de las directrices de acción propuestas en la primeira versión de la Política Política Pública para Popularización de la CyT (Moreira, 2005):

> *Buscar una mayor presencia de la CYT brasileña en los medios de comunicación. Aumentar la autoestima de los brasileños en este dominio, con una justa apreciación de las contribuciones de los individuos, instituciones y empresas nacionales.*

Otros ejemplos pueden ser identificados en las líneas de acción financiadas por la convocatória *Edital para Apoio a Projetos de Difusão e Popularização da Ciência e Tecnología* de 2006 (CNPq, 2009):

> *Producción de textos de divulgación científica destinados a los diferentes medios de comunicación como periódicos, revistas, radio, tv e internet;*
> *Creación de softwares y sites para educación y divulgación científica y de redes de comunicación dirijidas para actividades de popularización de la CyT;*
> *Divulgación, a través de diversos medios, de informaciones y resultados de la CyT producida en el país, así como de la obra de científicos e inventores brasileños, de forma que alcancen al público escolar y a la población general.*

Un aspecto central que permea las actividades desarrolladas en la lógica informativa es la necesidad de alcanzar un *público amplio*. Este elemento es um critério relevante para dar apoyo financiero a proyectos de divulgación científica presentados al Comitê Temático de Divulgação Científica del CNPq (Navas, 2008).

Por otro lado, el análisis realizado nos permitió identificar, también, indícios de actividades dialógicas. Entre ellas, la creación de Centros Vocacionales y Tecnológicos en diferentes estados del país, dentro del programa *Difusão e Popularização da Ciência* del Plan Estratégico *2004-2007* (MCT, 2003). Estos centros podrían remitirnos a un rescate y valorización de conocimientos y experiencias locales en tecnológia y a una búsqueda por establecer un diálogo entre estos conocimientos y los de los especialistas.

Es, sin embargo, en la Política Pública Para Popularización de la CyT donde encontramos clara evidencia de acciones dialógicas que todavia no han sido implementadas por el gobierno, pero que son sugeridas para los próximos años.

Para ilustrar esta afirmación vemos que las directrices de acción propuestas em dicha política, pretenden (Moreira, 2005):

> *Promover acciones que estimulen el aumento de la participaciónn de jóvenes de todos los segmentos.*
>
> *Estimular que las actividades de Comunicación Pública de la CYT no se restrinjan a las áreas de ciencias exactas y naturales, sino que incorporen también las ciencias sociales y humanas.*
>
> *Promover interacción entre ciencia, cultura y arte, con una aproximación mayor entre la CyT y el cotidiano de las personas, valorizando los aspectos culturales y humanísticos de la ciencia.*
>
> *Respeto y reconocimiento de conocimientos populares y tradicionales.*

Estas diretrices reflejan aspectos clave que caracterizan las actividades que definimos como dialógicas, entre ellas la negociación de conocimientos entre diferentes actores sociales y la concepción de ciencia contextualizada junto a otras manifestaciones culturales.

Algunas reflexiones

Como visto, por medio del análisis realizado, el Ministerio de la CyT de Brasil (MCT) le dado gran peso a actividades informativas de popularización de CyT, privilegiadas a través de medios de comunicación masivos y de beneficios, en términos finacieros, a proyectos de investigación y desarrollo. Creemos que para el MCT este tipo de práctica sea proritária para permitir que informaciones y conocimientos de CyT lleguen a amplios sectores de la población, siguiendo una lógica de "inclusión" de conocimiento.

Aunque algunas de estas acciones se enmarquen en la producción nacional de CyT, ellas se fundamentan en procesos unidireccionales de difusión de información y en el dominante modelo de déficit de comunicación pública da la ciencia. En este sentido estamos de acuerdo con Trench (2006), autor que afirma que las estrategias e inciativas de várias instituciones, incluyendo la gubernamentales, permanecen todavía en el modelo de déficit y continúan

atribuyendole a los científicos el papel de direccionar aquello que el público necesita saber y compreender sobre CyT.

En relación a las actividades dialógicas vimos que, aunque ellas aparezcan apenas como indícios, con la propuesta de los Centros Vocacionales y Tecnológicos del Plan Estratégico 2004-2007, ellas están claramente identificadas como propuesta de acción en la Política Pública para Popularizacíon de la CyT. Este hecho nos lleva a pensar en la relevancia que el tema de la participación ciudadana está adquiriendo para el MCT y la necesidad de legitimarlo por medio de una política pública.

Las consideraciones anteriores nos revelan la existencia de tensiones en el discurso de popularización del gobierno brasileño, que se muestra permeado tanto por elementos asociados al modelo de déficit , que privilegia la transmisión de información, como al modelo participativo de comunicación pública da la ciencia, que busca la superación de los modelos tecnocráticos. En este punto concordamos con Irwin (2006) quien asocia el surgimiento de tensiones y contracciones en los discursos emergentes de CyT de los gobiernos con (1) la combinación de una nueva retórica, que promueve la participación del público, con "lenguajes" antiguos y (2) la existencia de asuntos, todavía no resueltos y relacionados con el estatus epistemológico de la popularización de la CyT.

Esas reflexiones suscitan algunos interrogantes que dejaremos abiertos y que podrían ser abordados en nuevas investigaciones. El gran peso dado a las actividades informativas puede indicar que predomina el modelo de déficit en las actividades de divulgación científica implementadas por el gobierno brasileño? Qué representa para el MCT la convivencia entre modelos informativos y dialógicos y, en consequencia, entre el modelo de déficit y el modelo participativo de comunicación pública da la ciencia? En que estacios o por medio de que acciones podrían llegar a implementarse las acciones participativas propuestas en la política pública para popularización de la CyT?

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DISCUSSING BIODIVERSITY IN DIORAMAS: A POWERFUL TOOL TO MUSEUM EDUCATION

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The Origin of the Diorama

From their conception, museums, in particular natural history museums, established a relationship with the diversity of life on Earth. Through their collections and exhibitions, these institutions served as the link between the public and the richness of this diversity. This legacy originated in the private collections of European nobility in the 16th century. Having no scientific purpose at that time, these collections bestowed prestige upon those who owned them and testified to the importance of their social position (MONTPETIT, 1996). The collections, comprised by plant and animal specimens and historical objects, were to become the famous Cabinets of Curiosities the goals of which were to exhibit all "things in the world". The 17th century was marked by great expeditions and a resulting increase in the collections of animal and plant specimens leading to the construction of buildings intended to house them (BRAGANÇA & GIL, 1988; MERHOFF, 1997). This development continued in the 18th and 19th century where the establishment of natural history as a science led to the construction of numerous museums around the world which aimed to preserve life diversity by means of their collections. Up to this moment the collection was at the same time an exhibition; there was no practical distinction between them.

The 19th century marked a gradual autonomisation of the relationship between the collection and the exhibition. A modern epistemology emerged in which it

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no longer was sufficient for specimens and objects to be presented in a tableau of scientific knowledge; now, objects were arranged according to their role in the discourse which articulated them in a narrative, challenging and involving the visitor. From being rooted in specialised knowledge such as taxonomy, exhibitions now became based on references to real-life situations, reflecting the perception schemes that guide everyday conduct (MONTPETIT, 1996). The diorama, a three-dimensional, life-sized, simulated environment in which models or taxidermied animals are placed in order to depict a scene or an event (INSLEY, 2008), has its origins in this museographic notion of exhibiting a fragment of reality.

Since its conception, the diorama has been widely used in museums and as a result has been attributed different definitions. The literature that seeks to define dioramas generally emphasises the idea of *representation* (LURIE, 1983; ASENSIO & POL, 1996; ASH, 2004; BRESLOF, 2005); for some authors this representation includes the real object, the proper specimen, whereas for others this aspect is not so evident; however, they all underscore the importance of the scale of the objects that are presented in their real size and in a realistic setting. The diorama is thus based on a principle of analogy where the exhibited objects are arranged to in a visual representation of a real reference world (MORTENSEN, 2009).

Biodiversity in Museums

Natural history museums were virtually the first places to register and document life diversity. Mehrhoff (1997) points out that since part of what we currently know is based on what is contained in museums, they constitute important documentation of the diversity that has existed on the planet. In addition, the museums continue to provide new information because they continuously receive new specimens and have species classified in their collections. Mehrhoff further states that the real value of collections lies in the fact that they represent irreplaceable knowledge on life diversity in time and space, and to preserve them will help us to understand the richness of life on earth (ibid.).

In Mehrhoff's opinion (1997), rather than seeking to promote such understanding, museums should attempt with their exhibitions to arouse people's *interest* in biodiversity. In our opinion, this is the major challenge faced today by not only natural history museums but by any museum that exhibits biodiversity. Museums have developed a structure and organization with the specific aim of fitting their needs as a research institution to a

relationship with the public *via the medium of the exhibition*. This clear intention to communicate to and educate the public in the best way possible has brought to museums a new type of professionalism and consequently new approaches to exhibition development.

An example of how a new scientific trend was historically reflected in natural history museums is the consolidation, which took place in the 20th century, of ecology as a scientific procedure. According to Van Präet (1989), at that time studies relating to the notion of *species* shifted from a focus on the organism *per se* to the relation between the organism and the environment. In order to exhibit this complexity, museums employed resources such as dioramas which could represent to the public the complexity of nature, including, among other aspects, new values such as conservation and biological relations that went beyond the diversity of organisms (VAN PRAET, 1989).

Dioramas as Educational Spaces

Exhibitions are particular places for the analysis of important aspects of museum education. Elements as objects, space, time and language must be considered to gain an understanding of the educational processes and to plan the educational actions that take place there (VAN-PRÄET & POUCET, 1992; MARANDINO, 2006). In this perspective, dioramas are convenient study objects and in our surveys, we have analysed them as important milestones in the progressive change of natural history museums from places that housed collections into material educational spaces concerned with teaching and mediating biological concepts.

Regarding the impact on the public, researchers point out that in addition to being environmental representations, dioramas play an important role in reminding the public to preserve nature and in enabling contact with an environment that many of the visitors may never have experienced first-hand (ASH, 2004; BRESLOF, 2005; QUINN, 2008). In our opinion, dioramas promote an interaction between visitors and the involved scientific aspects because the behaviour of a visitor to a diorama may be considered similar to how a naturalist observes a new environment. Quinn (2008) corroborates this view in his comment about the proximity that a diorama has with the natural environment and what reactions this may stimulate in visitors. In Quinn's opinion this potential is an outcome of the exactitude with which a diorama represents an environment: "This is possible because dioramas bring more faithful representations than zoos, for example, they re-create the space where organisms are found more precisely" (QUINN, 2008, p.1).

However, some researchers, including Van Präet (1989), discuss dioramas from another perspective: the ecological conceptions that the public form when observing a diorama are much closer to those of the museum staff who constructed the exhibition than those of scientists. The preparation of specimens exclusively for the exhibition, and not for research and collection as was traditionally the case, is important. Here, the models or taxidermied animals are shaped to show the public various aspects about their behaviour, their relation with other animals (specimens) and the environment. Taxidermists and museologists have a significant task in producing objects that will mediate science concepts to the public based on the way they look and are placed in the exhibit. In others areas, such as palaeontology, the use of the combination of original specimens and replicas is related to both the way scientific knowledge is produced and the vulgarisation of science, revealing the tension between specialists and museologists in the construction of an exhibition (VAN-PRÄET, 2003).

Clearly, the intention of educating visitors through dioramas is common. However, we saw that although on the surface they may look like totally static arrangements, they implicitly embody a more interactive quality, reinforcing further their educational role. This characteristic resides in the potential to translocate the visitor to the natural environment reproduced there. The combination of scientific and artistic knowledge aiming at giving greater ambience to dioramas is also a strong indication that this exhibition type was conceived for educational purposes. The question of whether dioramas reflect the products of science or they are only recreations to entertain and teach concepts to the public emphasise how important they are for museums, and for us represents a significant indication of the educational intention of these objects.

Exhibiting Biodiversity in Dioramas

As the term biodiversity has been widely used for some time, it has become imprecise as a concept within the scientific community, in particular in biology. Although it has been a focus of discussion in scientific academia since its origin, many attribute such a wide scope as resulting from the *Rio – 92* meeting held in Brazil which ratified the "Convention on Biological Diversity" or CBD and recognized it as the first world agreement aimed at sustainable use of all biodiversity components.

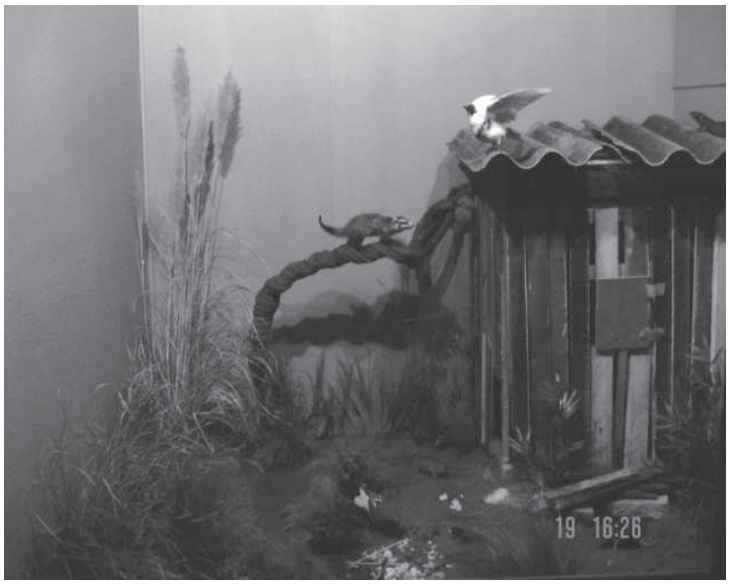
According to Motokane (2005), although there is agreement on the meaning of the term, we still do not have a consensus on its use among biologists. Corroborating this idea, Gaston (1996) goes further, pointing out the

unlikelihood of putting this into a common denominator. Weelie & Walls (2002) are categorical when they say that biodiversity is an ill-defined concept, being difficult to offer a simple or universally applicable definition of the term. They go on to say that it is not difficult to find scientific political or symbolic meanings being used by the same person.

The term biodiversity was blown out of proportion and goes beyond scientific limits with new meanings being incorporated. These new meanings have in turn demanded exclusive educational strategies from the places that intend to use it as a tool of articulation in education for science. The aspects found in the literature[4] that defines biodiversity can be divided into two major axes: *biodiversity levels* – genetic, species, and ecosystem diversity and *biodiversity values* – economic, ecological and conservationist values (OLIVEIRA, 2008).

In our work we found dioramas presenting biodiversity in both axes. Two examples can be shown above:

Detail of a diorama of Campo ecosystem – representation of the behavior of some species and their relation with the environment – Science and Technology Museum from PUC/RGS, Porto Alegre/Brazil (photos from Adriano Oliveira)



Diorama about the relation between environment impact and social problems - representation of the garbage problematique in a poor neighborhood Capão da Imbuia Natural History Museum/Curitiba/Brazil (photos from Adriano Oliveira)

The Diorama as a Tool for Museum Education

According to the panorama showed, we can affirm that dioramas are excellent tools to discuss how biodiversity can be shown in museums exhibitions. During a visit, those aspects related to the different dimensions of biodiversity that appear in dioramas can be outlined in the exhibition discourse, but also in other education activities promoted on those places. In our work we developed a workshop called "Constructing biodiversity: the diorama as a didactical tool", given to teachers and educators from museums. Our objectives are to promote the diorama as a good didactical tool to approach the specificity of museum education, but also to deal with education in contents of biology, geography, geology and history, to discuss biodiversity education, and to stimulate visits to museums.

Divided into three parts, the workshop first presents what is a diorama and its history, then introduces the main activity: the construction of a diorama. The diorama can be about an ecosystem, a habitat, a phenomena such as predation or the adaptation of an organism, but also about the garbage problem in a city, global warming, and so on. The dioramas are then constructed by participants using conserved or taxidermied animals and plants or replicas and low cost materials such as coloured paper to elaborate the scenario. Finally, with the dioramas finished, we prompt a group reflection

related to the objectives of the work shop, emphasising didactical and scientific aspects such as the biodiversity thematic.

In sum, the workshop experience can be both enjoyable and stimulating for the participants and promotes insights into some fundamental aspects of museum education and biodiversity in museums. Dioramas integrate scientific and artistic knowledge and for this reason, they are great tools for promoting understanding of the relation between the public and museums.

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The combination of traditional and interactive objects in science museums

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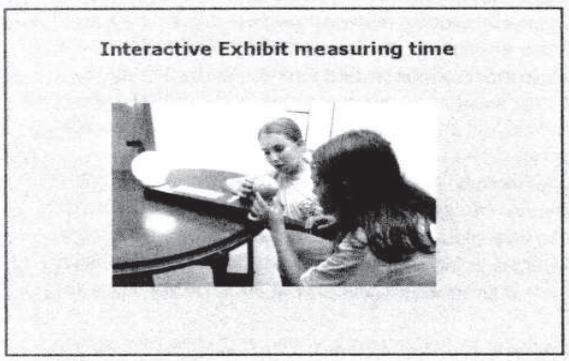


■ The questions posed by the theme of the CIMUSET Conference in Barcelona (July 2001) imply a discussion about objects in science museums and interactivity. This presentation analyzes the possibilities of articulating traditional objects (generally with a historical value) and so-called interactive ones and examining the types of objects present in museums. The presentation also describes the different strategies used to achieve efficient communication and to implement education by means of such objects.
In order to offer a clearer understanding of the development of our communication, we would like to point out that in our analysis of questions linked to Science Museums and their presentation to the public, we base ourselves on the principle that the museum as communicator is expanding its educational role.

First, we shall look at the environment/ambience in which science and technology museums have been implemented. Within this context, we present some aspects of these museums and their objects. Finally, some aspects are suggested for a possible discussion relating to a different statute of the science museum object that goes beyond conservation by including the intangible, touched on in the exhibition narratives.

The environment / ambience

The 20th century saw the relation between science and technical skills - and their unforeseeable advances - become a social question. This is especially true after the Second World War, when the introduction of controlled nuclear energy occurred simultaneously with the prevalence of economic models based on development and progress. In the 1950s and 1960s the image of science and scientists was gradually fixed in society: institutionalized science and professionalized scientists. During this period, the launch of the Sputnik (1957) was the crowning achievement of Soviet scientific progress and had an enormous social impact by making explicit within the field of education the chiasm between society and the understanding of the role of science.

This last event resulted in a process with worldwide ramifications, promoting an intense discussion that led to a transformation of the practices and the social role of museums. Science and technology museums played a leading part at the center of this movement. Their aims went beyond the preservation of important objects from the history of science, to concentrate

on the popularization of scientific principles, in order to encourage young people to enter careers linked to science and technology. Among their principles was a belief in the necessity of exposure to scientific method for the formation of citizens and not solely for the preparation of future scientists. So, a multidisciplinary museum arose that integrates science, technology and art and that uses interactive techniques of an experimental nature. These are the so-called Science Centres: a provocative space that attracts, seduces and motivates the visitor to make contact with the fundaments of Science and Technology based on an invitation to 'do it yourself'[1].

During the 1960s and 1970s, the dominant discourse emphasized technological advance at any cost. Interest was focused on science and technical museums, which were seen as means to bridge the gap between people, science and technology. By returning to the past this instrument was also used to modernize urban centers that, in addition to their own status, served to make the achievements of science and technique more dynamic.

In the 1970s, more precisely, interest in environmental education was intensified by reports of damage to the environment and by the awareness that society had a low level of ecological consciousness, with the objective of making society reflect on the social implications of scientific development.

During this period, a new approximation of science occurred with the social role of technology (the marriage of scientific methods with technical skills becomes technology) that was able to find a variety of solutions to the practical problems that affect peoples' daily lives. Regarding the great capacity of storing, processing, interpreting and accumulating information and the imposition of theoretical limits, science has partially abandoned its initial aims and becomes more pragmatic. No longer does research for a hidden truth guide scientific efforts, but instead something practical, that permits goals to be achieved with greater efficiency, whether by simulation models or virtual reality.
On the other hand, science has found in technology a very productive partner to work with in society in a global manner and we can observe a change in the scale of the effects of science and technology on society (the impact of computation, robotics, nanotechnology etc.). Until the 1980s, physics occupied the place of paradigm in the description of nature. Today, biology is taking an increasing place.

If we are able to distinguish in the immediate post-war period a moment that can be characterized as the Age of Science [2], in the last twenty years a different movement is perceivable. From 1980 onwards, we have entered a new era: the Age of Technology[3]. The questions raised in society, which was undergoing a recession and was marked by social movements in favor of political, economic, social and cultural rights as well as the construction of citizenship through education, also modified the role of the institutions whose main mission is communicating and socializing knowledge. This has a special effect on science museums, which must pay a greater attention to the implications of this new context.

Based on public opinion polls about the interest of individuals in knowing about science-related matters, two distinct groups appear within society. One group is formed by those who are interested in the fields of science and technology, in order to enable themselves to act as informed citizens. The other one is formed by individuals who demonstrate a low level of understanding of scientific and technological themes (nuclear energy, chemical additives, environmental control, genetic engineering etc.). Evidence suggests that there is congruence between the need to improve the level of understanding of science and the guarantee of lifelong education. Thus, one can see the vital role in this strengthening process of non-formal instances of education, especially science museums[4].
Within this context, science and technology museums received a new impetus. This impetus is so strong that it is perceivable all over the world. Museums arose in response to a demand and as a resource for improving the relationship of individuals with science and technology. However, one must note that this growth is still associated with educational measures intended to stimulate competitiveness and greater productivity, in harmony with the needs of business and industry, in which the logic of profit prevails over social questions.

Education has been highlighted as an important resource to confront the new challenges posed by globalization and by technological advances in the age of information. For this reason, the concept of education, which in the past focused mainly on teaching and learning exclusively linked to a formal school setting, has broadened. Thus it transcends the walls of the classroom and spreads into spaces such as home, work, leisure, etc. resulting in the birth of a new field of education: the non-formal education[5]. Today, several spaces contribute towards the same educational goal of filling gaps in society's knowledge. Within this context, museums are considered to be important sources of learning by contributing to an elevation in the level of culture of the society in which they are inserted: those who are in school, those who did not have such an opportunity and those who are no longer part of the school setting.
By broadening the educational dimension of museums, as spaces of preservation and 'guardians of the past', they come closer to those aspects in contemporary science that are inserted in a vision of history as a relevant characteristic of scientific thought, in other words, the universe is subject to permanent change and therefore has a history. In this instance, museums have emphasized the association of natural phenomena with history. History enables one to understand the process of events. It is this history that narrows the gap between the layman and knowledge as preserved and presented in the museum.

However, we live in a context of great complexity. This occurs because opportunities and risks present themselves in such a fashion that there is no way to foresee or control in a deterministic fashion the result of the processes under way. This complexity is increased when we take into account questions of territoriality, with the tendency within globalization for States to preserve themselves in this new environment as nations. Therefore, what is implied is the introduction of 'geographication'.

According to Santos, 'places fulfill and reveal the world, by 'historifying' and 'geographizing' it' [6].
Within this viewpoint, science also sees itself as unpredictable to the extent in which today it is no longer expected to cope with everything. These are elements of a new atmosphere requiring a new behaviour from society and also involving new demands on science education and popularization. If the beginning of the 20th century is marked by the mystification of science, by the end of the century the trend in education is to demystify it.

During the 1980s, many nations and the United Nations Organization for Education, Science and Culture (UNESCO) pledged themselves to fulfill an international commitment with respect to science education and to spread the idea of 'science for all' and throughout life, based on democratic principles and the respect for human rights. 'The scientific education of all students, for their roles as future citizens, was placed on an equal footing with the original and traditional objective of formal education in the sciences, related to the selection and preparation of future scientists'[7]. The same author further affirms that the knowledge of the adult public about most current and relevant scientific questions is not derived from experiences in school, but from the actions of scientific popularization (the great popularisers of science), from high quality electronic media and from science museums that bring to their exhibitions both classic scientific/technological knowledge and current or controversial themes.

The objective of these new museums and centres is to provide access to all by inviting the participation of the layman. Today, the individual is required to show a greater capacity to operate in different areas and an easeness of adaptation. All over the world, specialists in the area of science education have sought to implement science programs that can contribute to the formation of critical citizens, capable of appreciating science as part of culture, constantly seeking their own enrichment with regard to scientific culture, questioning the knowledge spread by the media and interacting consciously with the world around them[8].

These are some of the aspects that underlie the new forms of conceiving the spaces of museums and science centres. So, these new spaces now deal with current and controversial themes presented in such a way that individuals can participate as citizens, possibly by influencing political decisions.

The museum objects

Upon activating the popularizing role of the museum, it will be guided by a specific concept of science, based on a representation of science that will then be displayed in exhibitions where objects are present. These objects may be associated with presentations where science is portrayed as a crystallized knowledge, as an obstacle to the understanding of the visitor. And, in other cases, the objects are presented in such a way as to enhance the understanding of science as a process in transformation. Therefore, in order to discuss the articulation of traditional objects with so-called interactive ones, it is necessary to examine more closely the types of objects found in museums. A relevant bibliography on this subject already exists and several approaches have been proposed with regard to communication and education by use of objects [9]. Our presentation highlights the work of two authors.

Lourenço's study[10] proposes a system for the classification of objects for scientific and technical museums comprising three main types of objects: scientific objects, built for the purpose of scientific investigation; pedagogic objects, built for the purpose of teaching science; objects that popularize science, built for the purpose of presenting scientific principles to a wider audience. The first two types of objects are incorporated to collections because they are no longer used for their original purposes - and are commonly named 'historical objects' - and the third type of objects is built specifically to be manipulated within the context of an exhibition - these are currently named 'interactive objects'.

However, the author makes a reservation with regard to these designations; since in her view the attributes of 'history' and 'participation' are not intrinsic to objects - for instance, an historical object may, under certain conditions, become interactive and vice versa. Thus, historic value and interactivity are external characteristics that may be present in all objects, in different contexts. According to Lourenço it is the purpose for which the object was built – an internal criterion – that confers on it some objectivity and internal coherence. On the contrary, criteria based on external characteristics, such as interactivity or historical value, do not allow an objective approach to the problem, since these attributes are conferred during the appropriation of the objects and, in her view, are incapable of being controlled a priori.

From a different perspective based on the possibilities for presenting objects in exhibitions, Schärer[11] proposes seven approaches that indicate the intentions behind the display of an object, from the function attributed to it. The author defines types of exhibitive languages, such as aesthetic, didactic, theatrical and associative. In his opinion, objects in exhibitions may be mute, as in deposit-museums; seductive, as in dream-museums; illustrative, as in history book-museums; disorganized, as in theater-museums; educational, as in school-museums; significant, as in debate-museums; witnesses, as in narrative-museums.

Referring to these authors, one can affirm the existence of different forms of choice of the criteria for the classification of the types of objects in museums. If the choice is made according to internal attributes, the classification is, in general, more objective and generalist, and therefore independent of the context in which the object finds itself. On the other hand, a classification that takes into account the context, the object on display, tends to be less objective and as many criteria as situations in which the object can be displayed may exist. Nevertheless, the latter classification reveals the different forms in which the objects can be presented and interpreted by visitors, an important element for the communications process of museums.
In either classification, however, one can see that 'historic' and

'interactive"' attributes are not inherent to the objects. Above all regarding the question of interactivity in objects, several authors have discussed the way in which this term is being used in the museum environment. According to Falcão et al[12], the understanding of the concept of interactivity requires an analysis of the situations in which this term is usually used. Initially, interactivity arose as a counterpoint to contemplation, this last quality being common in museums that present objects which cannot be manipulated, inviting the visitor to behave in a reactive way while interacting with the equipment on display.
The term hands-on is also often proposed as being almost synonymous of interaction. However, the basic limitation of this level of communication would be that hands-on does not necessarily mean minds-on, in other words, the user may not, a posteriori, be able to build a meaning out of the experience. The authors quote Lucas, who criticizes the notion that any physical manipulation whatsoever of an apparatus promotes intellectual engagement. Thus, interactivity must be joined with a clear pedagogic conception that takes into consideration the specific characteristics of the spaces of non-formal education, especially with regard to the nature of learning that occurs in such places. If not, the interaction is lost in an innocuous attempt to publicize science to the general public.

So, we can see that the term 'interactive' has different nuances and that the fact that an object possesses the characteristics of traditional objects does not mean that it cannot have some degree of interactivity, here understood as a quality not restricted to exhibits of the hands-on type. Thus, the most important point is the manner in which the object is displayed and the approach used to propose the discourse about the object (meta-discourse). In our view, in the case of science museums, an approach that enables the treatment of the question of interactivity on its different levels in the discourse of exhibitions can be based on the history of science.

Facilitating interactivity in the museum

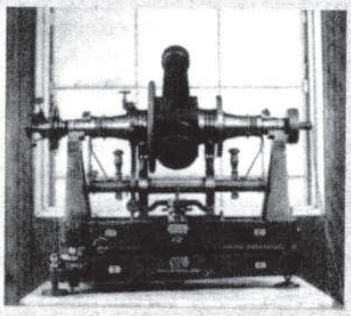
The exploration of scientific questions by means of the presentation of a historic process linking social and cultural aspects helps to promote a view of science as a collective human construction. It also contributes to the understanding of the hypothetical nature of the trial and error of scientific research. And it allows the visitor to understand that knowledge is reached by overcoming preconceived notions and obstacles by means of long and complex discussions taking place over time. In addition, the presentation of scientific questions by articulating different viewpoints enables a widening of the understanding of science, technology and social relations, bringing the public and scientific matters closer together and facilitating the understanding of science in a more ample fashion.

Scientific instruments help to introduce the relation between science and technical skills helping the public to give meaning to scientific content; but, the presentation to lay visitors of an instrument in isolation inevitably offers a very limited understanding of scientific thought. To the contrary, the instrument should be shown inserted within a context of interdisciplinary views, helping to bring science closer to the visitor. The scientific object only acquires meaning for the visitor if he or she is familiar, to a certain degree, with what is on display.

How can the historic dimension be introduced in a scientific exhibition without falling into a traditional technological approach

Example: the concept of time

The meridian telescopic sighting by observation of the sky permits the definition of the corresponding period of time for the day because of the regular rhythms of the sky



meridian telescopic

(an exhaustive exhibition of objects with emphasis on great deeds by great men)? An example may be to use the concept of time. Without introducing cyclical time and considering only linear time one can introduce the question by looking at techniques for the measurement of time. The meridian telescopic sighting by observation of the sky allows to define the corresponding period of time for the day because of the regular rhythms of the sky. This measure serves to calibrate a pendulum after transfer to a pressure chronometer. However, after the introduction of the atomic clock, time is no longer measured by the Earth's rotation but by the frequency of oscillation of a crystal. The first instrument – a telescope — gives us the key to understanding how we know our local time, by observing the passage of a certain star through a certain meridian. After the introduction of the atomic clock, time becomes a concept that can no longer be associated with any event of daily life and is now an abstraction. So, one can perceive the evolution of techniques for the measurement of time and the change in the conception of the notion of time as a function of the introduction of new elements of precision and frequency. This knowledge must be presented in a museographically conceived environment so as to facilitate understanding and, as pointed out by Lins de Barros without dispensing with the elements of cognition (intellectual interaction), communication (beyond the interaction of manipulation) and affect (emotional interaction). These aspects, according to the author, are essential for the total interaction of the visitor with the theme of the exhibition.

Therefore, the introduction of history in science museums allows to show science as a process of permanent research and to reduce the gaps in knowledge that are present in contemporary society. Science has changed our view of the world drastically and the function of the historian becomes more complex than the compilation of facts or the dedication to the exclusive memory of certain persons. Each generation rewrites the history of the world in light of new ideas and of the established knowledge of each era. The perception of this transformation enables the establishment of links between past and present concepts, reducing the gap between historical moments and incorporating cultural changes.

Until now we have discussed those museums that deal with objects, objects that have witnessed experiments that, while seen as technical, can be perceived as reflections of scientific thought. But if we shift to another side, what can be said about Science Centres that present equipment for the demonstration of scientific laws and phenomena? In spite of their great attraction for the public, they generally provide fragmented and incomplete knowledge, because of the lack of historical perspective. Here also the history of science has a role in linking abstract knowledge with the evolution of scientific thought.

While traditional Science and Technical Museums have difficulties in communicating a comprehensive view of current scientific knowledge, Science Centres present science devoid of relations, without background and outside a cultural context. However, the two approaches have a common goal: to stimulate scientific and technical education, for its intrinsic value and for what it represents as a conditioning factor in modern society. Thus, and as Bragança Gil[13] has suggested, it seems that the knowledge present in both would be better put to use if the two versions merged their positive aspects in a coherent museological combination. Then, Science Centers would also be interested in the past and Science and Technical Museums would be interested in experimental science and in contemporary technology, both showing the changes in scientific and technological thought and as a product of transformations in contemporary and past human relations.

Reflecting about objects

Above, we saw how objects have intrinsic historic and phenomenological meanings. From the point of view mentioned above, we analyzed the processes and the phenomenon, something that lies outside the physical concreteness of the objects as part of its intangibility.

Nature and the environment create links with museums that are submitted to the scientific and social representations of our society, be they about nature, objects and, of course, about the museum. The current dimension of the museum as a place of communication cannot obscure this element.

According to Van-Präet[14], at the end of the 19th century, it was considered to be of fundamental importance for the museum to no longer be limited to an inventory and description of each element in our natural and cultural universe, but, on the contrary, also to explore natural and social processes as a way in which to extend our knowledge of nature and of how knowledge is produced. The emergence of new representations and 'disciplines had an impact, at the end of that 19th century, in the concepts and working of museums, especially science museums. On the one hand, the large scientific instruments that constitute these institutions should not be put at risk, a danger always present in exhibitions. But, at the same time, actions of popularization are seen as indispensable, both to spread new concepts, such as evolution, ecology etc., and to avoid the isolation of the scientific community from society. This dilemma - maintaining the research instrument in a collection and organizing exhibitions - will be solved by the creation of the modern concept of museum, which divides the museum's space into a reserve collection (henceforth the sole domain of specialists) and exhibition galleries.

For over a century, museum and heritage professionals have been pondering the question of how to progress from the principles of conservation and exhibition of material evidence (naturalized species, fossils, instruments, works etc.) to those, still under elaboration, of conservation and presentation of natural, cultural, technical and other processes, which originate in the intangible. This question implies the consideration of, in addition to the traditional assets of the museum, intangible assets, not only in the spheres of museums of ethnology, history etc., but also in scientific and technical ones.
Reflections about intangible heritage are linked to aspects related to the conservation of processes and phenomena. This heritage includes culture and nature, and, within nature,

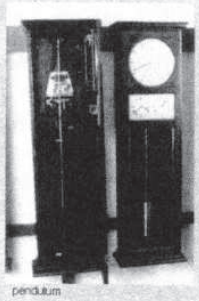
encompasses all acts of creation, including Science. Thus, contemporary scientific and technical museology cannot refrain from reflecting about and investigating this intangible heritage[15]. The Science Centres also arose from the 1930s onwards from the same wish to present the intangible heritage constituted by scientific creation. It is thus possible to affirm that these places constitute a reply to the desire to propagate this intangible heritage comprised by scientific and technical creations, and innovative strategies of animation, demonstration and innovation have been developed in these spaces.

However, we agree with Van-Präet in considering that the success of an exhibition is, above all, in the operationalization of a network of conceptions in which the development of content and form combine several procedures. In the same way as the arrival of the intangible heritage profoundly restructured the museum as an institution, transforming science museums and leading to the creation of science centres and nature parks, it is fundamentally important today to overcome the current forms of mediation, to answer the challenges of communication of the intangible heritage imposed by society, by economic development, by the quality of life etc.

Thus, scientific exhibitions, of whatever genre, must mobilize participation, emotion and aesthetics, so long as this stimulates the visitor with regard to the exhibition. In addition, they cannot show only the natural or scientific domains perceivable during the time of one visit to a natural space or to an exhibition. Van-Präet shows some alternative paths that are yet to be established, for the development of exhibitions from this standpoint. These alternatives imply in telling the public that visits museums: i) that the heritage of scientific creation is much greater than what is exhibited in museums; ii) that the natural heritage is not only submitted to the interactions visible in the here and now. In addition, one cannot renounce competencies that are the fruit of several centuries of the use of objects in the museology of science to make explicit the function of objects in collections, not only of a past knowledge, but of a knowledge that is in the making and, therefore, one must risk emotion and support the effort (which is not opposed to the pleasure) of protecting the intangible heritage, including that which originates in the museology of science.

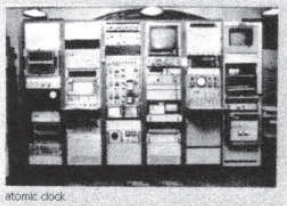
Therefore, it is of fundamental importance to emphasize that, in the analysis of collections of natural history, both substitute and authentic objects are pertinent concepts in this specific field. All heritage is a human construction and, therefore, belongs to the domain of the intangible. So, the statute of the substitute or the original must be called into question, since the statute of originality itself is not identical to the one that can be defined for the arts. As Van-Präet shows, the work to assemble pieces for display in the field of paleontology spontaneously evokes the concept of an 'installation' in contemporary art, including the fact that the museographer is confronted, during the assembly of the exhibition, with a living creator: the paleontologist who invents/creates the fossil on the one hand and the creative artist on the other.
The use of models and sculptures is developed in parallel in many exhibitions, but, above all, the notions of real and substi-

This measure serves to calibrate a pendulum after transfer to a pressure chronometer



pendulum

pressure chronometer



atomic clock

After the introduction of the atomic clock, time is no longer measured by the Earth's rotation but by the frequency of oscillation of a crystal

tute come up, like in paleontology, against limits that must be mentioned to visitors. Therefore, though the use of models is frequent in fields such as paleontology and, to a lesser extent, in zoology and anatomy, in the physical sciences, among other fields, the use of substitutes is examined from a viewpoint different from the debate on authenticity and fiction.

In this instance from the field of natural history, the fact that should probably be most emphasized to visitors is that none of the specimens displayed are 'truly natural'. All are substitutes, or more precisely the product of knowledge, which does not prevent the visitor from feeling emotion when confronted with the paleontological assemblage or with a naturalized specimen. This approach promotes the idea that museum objects, as well as exhibitions, are social constructs.

So, although the discussion presented by Van-Präet is inserted in the context of natural history museums, this case helps the discussion presented herein since it calls into question the statute of authentic and substitute objects in museums. If we consider that science centres use objects that are mainly models, therefore substitutes and representations, questions about the adequacy of these objects for the popularization of science become irrelevant. Once again, the most important thing is communication with the public to further the understanding of science as a social and historical process, which can be accomplished by historical or interactive objects.

Finally and bringing together the different points raised in this work, we would like to add that museums have close ties to society and are vehicles for its representations and, thus, the museum in its communicative and educational dimension cannot neglect its relation with the public. The demands of society today assume the restructuring of museum culture by adapting new ideas to the existing institution without, at the same time, disregarding the latter's historic potential. Therefore, there is now a tendency to seek a balance between the interest in historic objects and the interest in the demands of society. In the words of Eilean Hooper-Greenhill[16] 'the old principles of conservation must now share their predominant role with the new concept of negotiation'. The act of collecting, as an end in itself, is no longer sufficient in itself; on the contrary, it must be seen as a way in which to reach out to people and their interests.

Résumé

Cet article reprend la communication présentée lors du colloque du CIMUSET (Comité interrnational pour les musées des sciences et des techniques) à l'occasion de la Conférence générale de l'ICOM à Barcelone (2001). Il se veut une réflexion sur le rôle des objets dans les musées des sciences et des centres scientifiques. Les auteurs analysent l'évolution depuis le XIX[e] siècle du concept de la communication envers le public des notions scientifiques ainsi que la place de l'interactivité et de l'implication des visiteurs dans les prises de conscience des problèmes liés à l'environnement.

Resumen

Este artículo trata sobre la ponencia que se presentó en la conferencia del CIMUSET (Comité Internacional para los Museos de Ciencia y Tecnología) durante la Conferencia General del ICOM en Barcelona (2001). Es una reflexión sobre el papel que juegan los objetos en los museos de ciencias y en los centros científicos. Los autores analizan la evolución en el concepto de la comunicación de nociones científicas hacia el público que tuvo lugar desde el siglo XIX, así como el lugar que ocupa hoy en día la interactividad, y la manera en que los visitantes se involucran en la toma de conciencia de problemas con relación al medio ambiente.

■ NOTES

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ARTIGOS / ARTICLES

The scientific museums of the University of São Paulo, Brazil, and their search for an identity

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Abstract

In this article some of the challenges faced by the scientific museums of the University of São Paulo (USP), Brazil, are presented. Based on a brief description of four USP museums – the Museum of Zoology, the Museum of Veterinary Anatomy, the Oceanographic Museum and the Science Station – the difficulties of characterizing university museums and their objects are discussed. The broader debate of what characterizes a scientific museum in general is also taken into consideration. Finally, some remarks concerning university policies towards the role of heritage in establishing links with the community at large are presented.

Resumo

Neste artigo é apresentada uma discussão dos desafios que hoje enfrentam os museus científicos da Universidade de São Paulo (USP), Brasil. Discute-se inicialmente a problemática da classificação dos museus universitários e, em especial, dos museus científicos da USP, sublinhando as dificuldades na respectiva caracterização. Com base numa breve descrição de quatro dos museus científicos desta universidade – o Museu de Zoologia, o Museu de Anatomia Veterinária, o Museu Oceanográfico e a Estação Ciência, realiza-se uma reflexão sobre as dificuldades da adopção de critérios baseados no acervo para classificação dos museus científicos universitários. Discute-se ainda o problema, evidenciado na literatura e nas práticas na área da museologia da ciência, quanto à classificação dos museus de ciências. Por fim, pontua-se a necessidade de estabelecer uma política universitária de extroversão do património científico que tenha em conta as particularidades e a diversidade dos museus científicos universitários.

Introduction

Most scientific museums[1] either belong to or are related to universities. Given the alleged crisis universities are facing, these museums encounter growing difficulties and challenges. WARHURST (1986: 137) stated that the university museums' crisis starts with the difficulty of identifying what a university museum is. Even considering definitions such as the one in the Manual of Curatorship[2], Warhurst believes that "there are (...) university museums which do not satisfy these criteria".

In spite of the diminishing resources, some university museums are trying to find an identity of their own and make efforts to provide a new meaning to their existence. As WARHURST (1986: 137) points out, university museums face a triple crisis: "a crisis of identity and purpose; a crisis of recognition; compounded by a crisis of resources".

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[1] In this text, I include museums presenting 'natural' and 'exact' sciences to the public under the broader designation of 'scientific museums'.

[2] The Manual of Curatorship states that "A university museum is a museum whose building is owned by a university; whose collections are owned by a university; and whose staff are employed by a university – for the most part".

In this article, some of the challenges currently faced by the scientific museums of the University of São Paulo (USP), Brazil, are discussed. Data have been gathered in the course of a PhD research at the Faculty of Education of USP, aimed at exploring the ways biological knowledge is presented in scientific museums' exhibitions and particularly in the construction of the exhibition discourse. First of all, a preliminary inquiry was conducted in order to identify scientific museums in the USP that presented biological exhibitions. However, this inquiry revealed some classification problems, apparently acknowledged by the University boards and personnel. Moreover, these problems were not geographically restricted or exclusively related to the Brazilian university museums context. In fact, a worldwide classification and identification problem is, among others, affecting museums and causing some interesting museological problems. In this paper, criteria used to select and characterize the USP's scientific museums are presented and data from interviews, documents and site visits are used to discuss some of the problems that they are currently facing.

Characteristics of USP Collections and Museums

To ABREU (1999: 11)[3], the University of São Paulo - created in 1934 - has been incorporating, for purposes of teaching and research, "very diverse scientific, cultural and artistic collections, that could be generally called museological collections". This accumulation of objects was slow at first but increased in the 1990s, indicating that it will probably be reinforced in the near future. According to Abreu (1999), this coincided with the progressive shift from a "sacred place" into an education-oriented "social arena", which the museum world underwent during the 1970s. These changes, directly related to a stronger presence of 'cultural industry', would have produced 'pattern' knowledge and 'value' mechanisms that included a strong 'marketing' presence, with clearly global perspectives, independent of social classes' (ABREU 1999: 11). Abreu clarifies that this context is relevant to understanding the value of collections in USP museums, which was strongly influenced by the 'new museology' movement.

Officialy, the USP has four museums, belonging to what is called the USP 'integration organ'[4]: the Paulista Museum, the Museum of Zoology, the Archaeological and Ethnological Museum, and the Contemporary Art Museum. Excluding the latter, the collections had their origin:

> "(...) in scientific and cultural pioneer expeditions that occurred in the State of São Paulo during the last decades of the 19th and the beginning of the 20th century. The original core was organized by Colonel Joaquim Sertório, and was donated to the State Government of São Paulo in 1890. At the beginning, the Sertório Collection was placed under the jurisdiction of the State Geographic and Geological Commission, created in 1886 by the geologist Orville A. Derby. They were integrated in the Paulista Museum when this was created, in 1893. The Paulista Museum was inaugurated in 7 September, 1895." (ABREU 1999: 11).

Nowadays, the collections are diverse and have distinct roles in teaching, research and cultural action. First mentioned by ABREU (1999), this diversity was confirmed during my research. However, objects exhibited have some common features, specific to university museums.

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[3] Adilson Avancini Abreu is Assistant Rector of USP, responsible for culture and university cultural action. His paper was presented during the II USP Museum Week (August/September 1999).

[4] According to ABREU (1999: 12) the museums of the 'integration organ' explore their collections giving particular attention to interdisciplinary aspects that improve the educative processes linked with the USP's Units of Teaching and Research. As we will see, USP has more collections.

Selecting USP's museums for research

The selection of museums studied was based on a list informally provided by the USP Cultural Heritage Commission[5]. The list included c. 20 museums related to the biological sciences. Among them, three types of collections were identified: i) reference collections, used exclusively by researchers from the USP research units and departments; ii) didactical collections, used by professors in their classes and usually not open to the general public; and iii) collections organized and exhibited for the general public. Because the main objective of the study was public communication, museums and collections not available to the general public were excluded. Naturally, other museums and collections were excluded for more prosaic reasons, such as limited time or lack of authorization to conduct the research. Another criterion was to approach different types of scientific museums – natural history and science & technology.

Based on these criteria, four museums were selected: i) the Museum of Zoology, ii) the Museum of Veterinary Anatomy; ii) the Oceanography Museum and iv) the Science Station. The main characteristics of these four museums are briefly presented below[6].

The Museum of Zoology[7]

As mentioned before, the Museum of Zoology has its origins in the Sertório Collection[8]. The permanent exhibition was conceived in the beginning of the 20th century and reformulated in the 1940s. The Museum includes the most diverse zoological collection of the neo-tropical region, comprising c. 7 million specimens (Rodrigues, 1999). From the beginning, the Museum's mission comprised the organization of the collections and the promotion of scientific publications in Zoology, as well as related topics. In the 1960s, the Museum initiated post-graduate teaching activities, as a Department of the Agriculture Secretary of State and in collaboration with USP Faculties of Philosophy, Science and Humanities. In 1969 the Department was integrated in USP and the Museum was renamed the Museum of Zoology of the University of São Paulo. In spite all these changes, the permanent exhibition still dates from the 1940s and only minor changes have been made since.

The exhibition of the Museum of Zoology reflects 18th and 19th century natural history museology. Since these museums were from the beginning considered institutes of production and diffusion of scientific knowledge, specimens presented are arranged in a systematic way, gathering in groups exemples of the same taxonomic group. There is little information on the specimens, and when there is, this is always related to the systematics or behaviour of the taxon exhibited. Dioramas presenting ecology and biogeography concepts, also common in 19th century natural history museography, can also be found. Currently, the Museum of Zoology develops research in the fields of systematics, ecology and evolution.

[5] The list was made by the USP Cultural Heritage Commission and constituted an attempt to survey all USP museums. Although it is not an official document, it was used in this research as a guidance list. A more thorough survey was conducted by this Commission and will soon be published.
[6] All the information presented here is based on official documents, articles written by researchers, as well as data obtained from interviews.
[7] The exhibition of the Museum of Zoology was closed at the time of the research and could not be visited.
[8] According to Lopes (1997), the Sertório Collection was part of the Paulista Museum, a São Paulo's State museum, in the 1890s. During the 1920s, the collections of the Paulista Museum were dispersed and it became a museum exclusively devoted to national history, Brazilian ethnography and national numismatics. The Zoology collections formed the Museum of Zoology, which in turn was integrated in USP in the 1960s.

As far as organisation is concerned, the Museum of Zoology is divided into three sections: 1) the Cultural Diffusion Section, with two sub-sections – Education and Museology; 2) the Scientific Section, divided into the Vertebrate and Invertebrate sub-sections; and 3) the Administrative Section. The Museum is located in Ipiranga, a traditional São Paulo middle class neighbourhood outside the university campus.

The Museum of Veterinary Anatomy

The history of this Museum collection is intertwined with the very history of the creation of the Veterinary Anatomy course at USP. At first, students of Veterinary Anatomy courses received training together with students of Human Anatomy. Later, as a result of a growing interest and practice in teaching and research, several anatomical objects were brought together. In 1969, the Veterinary Medicine Faculty became an autonomous body within USP and it then occupied a few warehouses belonging to the Polytechnic School. The objects were arranged in corridors near the classrooms, so that they could be seen by everyone. Furniture was provided by the Museum of Zoology and a few skeletons were put side by side on shelves. This area was commonly known as 'the museum', meaning that it could be visited by the 'public'[9]. In 1984, the Museum moved to its current building in the Anatomy Veterinary Faculty inside the USP campus.

Ever since its early years, the Museum had strong links with anatomy teaching and it depended

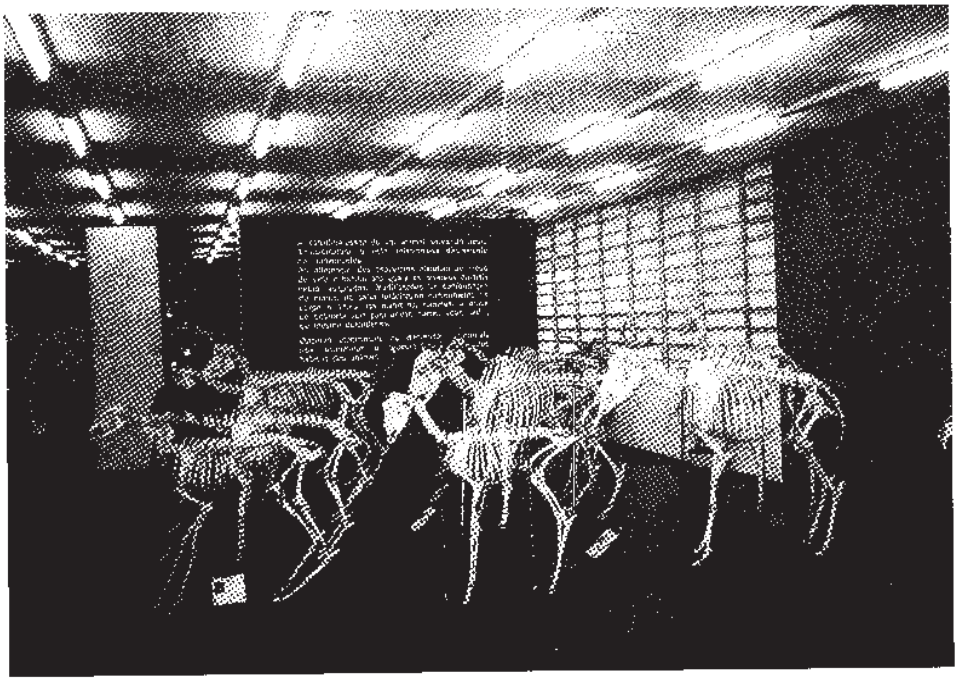

Fig. 1 – The Museum of Veterinary Anatomy, USP (Photo: M. Marandino).

[9] In fact, 'the museum' was not only available to students. Due to its location, the general public taking pets for veterinarian consult could also visit it.

administratively and financially on the Veterinary Anatomy department. The collection was accumulated through exchange, collecting, donations from São Paulo's Zoo and, especially, from objects prepared by PhD students and researchers.

The exhibition used to be organised according to taxonomic criteria, with an area devoted to birds, another to bovids, to equids and to suids. Each one of these areas was loaded with skeletons and anatomical objects related to a particular animal group. In 1993, the Museum recruited a museologist and some changes were made. With the help of a biologist, the Museum team updated the animal systematics and began the organisation of a collection documentation system. Specimens in the exhibition were re-arranged, although no major changes in the original taxonomic organisation occurred. The clearest changes took place as far as communication is concerned, with the introduction of colours and an increased value attributed to visual elements. The Museum team included panels with some basic scientific information and the presentation of some particular collections was further developed, such as the 'hearts exhibition'. Moreover, visitors were more explicitly taken into consideration, which created the need for more explanatory elements.

Therefore, the exhibition was developed around the idea of 'look, observe and compare', in order to promote a public awareness of common characteristics among different animals. An introductory area where visitors can manipulate a few anatomical instruments and consequently learn about anatomical techniques also indicates this visitor-oriented approach.

Fig. 2 — Some objects to touch (*Toque*), in the permanent exhibition of the Museum of Veterinary Anatomy. Behind, the label 'Look, observe and compare' (*Olhe, observe e compare*) (Photo: M. Marandino).

The Oceanography Museum

The Oceanography Museum was created as a result of the political will of a few members of the USP Oceanography Institute. In 1986, a committee was formed in order to analyse the viability of creating a museum and, in 1987, this commission issued a proposal that was accepted by the Institute's director. The Oceanography Museum was then officially created and, between 1988 and 1989, three full-time employees were given the task to implement the project. This team later suggested the inclusion of an aquarium. It should be noted that an aquarium was considered right from the start, but separate from the Museum. During planning, the team's choice was to integrate it, corresponding to the idea of integrating 'live' (aquarium) and 'dead' collections (museum). Administratively, the Oceanography Museum was created as a section of the Oceanography Institute and its collections result from research in the Institute. These include biological specimens, as well as collecting instruments, photographic documents, and equipment from the Antarctic Expedition of 1983. These objects are displayed in the permanent exhibition, along with models and texts produced by the Museum team. The Museum is located in the Oceanography Institute, within the USP campus.

The exhibition aims to explain what Oceanography is, what oceanographers do and what research is done at the Institute. It is divided into three parts, according to a disciplinary approach: 1) Physical Oceanography; 2) Chemical Oceanography and 3) Biological Oceanography. Topics include information from the seas obtained by the Institute and collecting and measuring equipment used in oceanic studies. Visitors

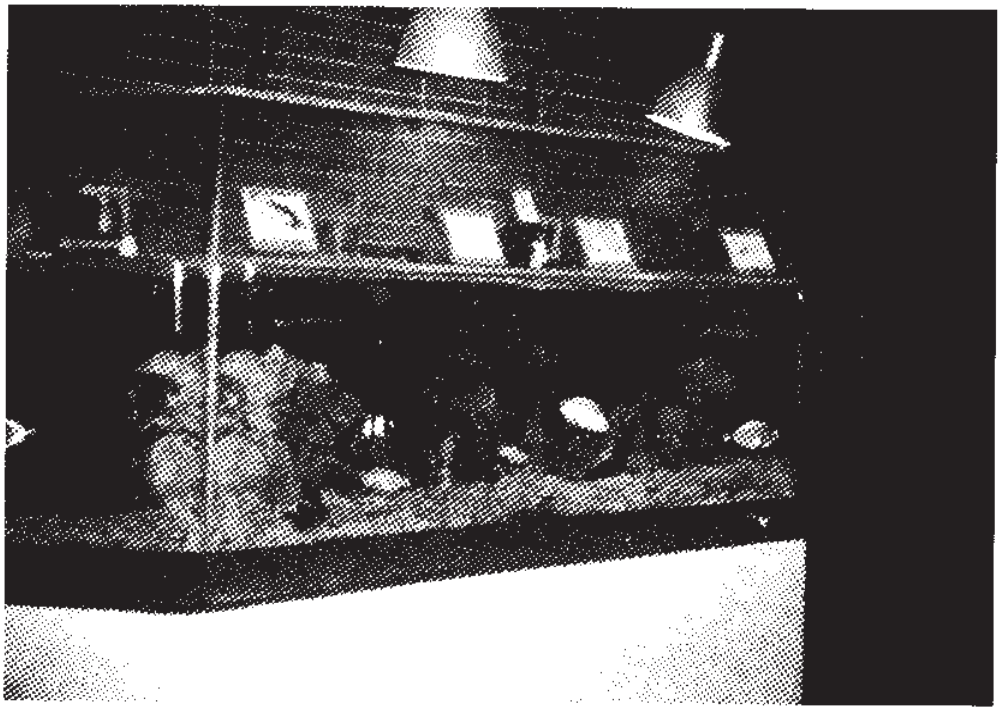

Fig. 3 — An aquarium at the Oceanographic Museum, USP (Photo: M. Marandino).

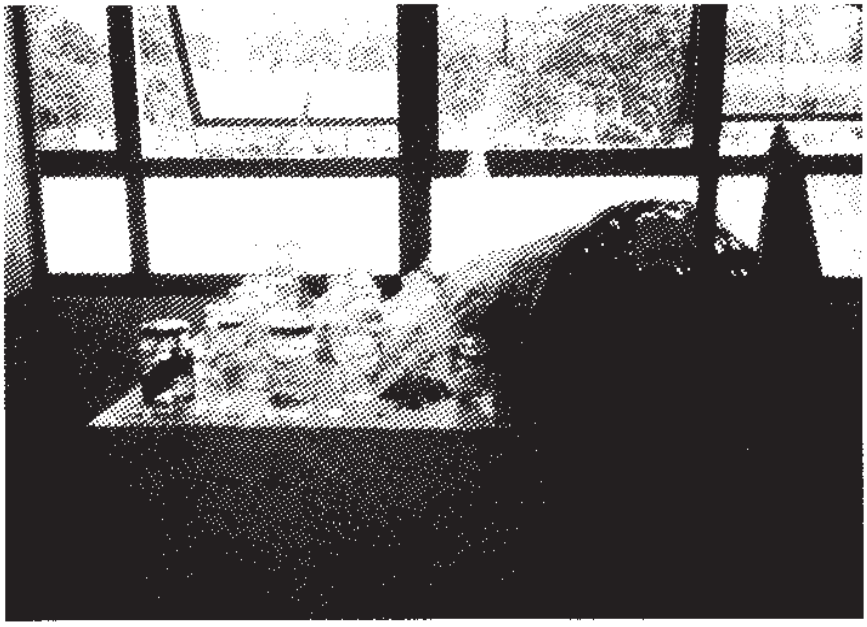

Fig. 4 — Specimens in flasks and other 'natural' objects at the Oceanography Museum (Photo: M. Marandino).

will also find some explanatory panels with information concerning physical and chemical oceanography, mounted and preserved specimens and aquariums exhibiting marine ecosystems and living marine organisms. Moreover, the museum has an environmental education program, the 'Ecological Expedition – The School goes to the Sea', where secondary school students visit the Oceanography Bases of the Institute in the coastal areas around São Paulo. The main objective of this program is to provide information on marine ecosystems and raise awareness about the importance of the preservation of the seas.

The Science Station

Some members of the scientific community of the State of São Paulo created the Science Station as a result of a concern for science education. It was established in 1987, in a joint effort by the government and universities[10]. At the beginning, the Science Station was administrated by the federal government. However, with the governmental changes of 1990, the Science Station was incorporated in the University of São Paulo and it consequently underwent a re-organization to adapt to the new situation. Nowadays, the Science Station is ruled by the University Council, a body representing most of the University schools and faculties.

Although in appearance similar to a hands-on science centre, the Science Station was from the beginning conceived as a 'museum'[11], and its organizational structure reflects this concept. A storage area was constructed and extra or out-of-use participative

[10] E.g. the CNPq – The National Council for Research, the University of São Paulo and the University of Campinas.
[11] The Science Station argues that museums establish relations between people and scientific/cultural heritage, mediated by objects or phenomena, laws or principles. In this sense, a science centre is a type of science museum.

objects and experiments were organized and stored, just like artefacts in 'normal' museums. It was a kind of didactic and museographic storage for exhibitions. Other instruments and scientific equipment, obtained by donations, formed the Science Station's collection.

Exhibitions present interactive models covering Physics, Astronomy and, to a lesser extent, Biology and Chemistry. For the purposes of this research only the biological exhibits – three at the time of the visit – were analysed. Although different, all shared the Science Station 'spirit', inspired by the hands-on science museums and centres movement. The exhibits were: 1) 'Urban Birds', presenting birds from the city of São Paulo, with a computer connected to an electric panel to facilitate identification; b) the Aquarium, formed by a set of three fresh and sea water aquariums containing specimens from Brazil and preserved marine organisms in glass boxes displayed on shelves; and c) the 'Butantã Stop'[12], with 'dioramas' displaying living insects, amphibians and reptiles, together with 'The Drawer' (*Gaveteiro*), an interactive exhibit where some preserved specimens are kept inside drawers and can be manipulated by visitors.

The Science Station is located in an old train station in Lapa, a popular neighbourhood outside the University campus.

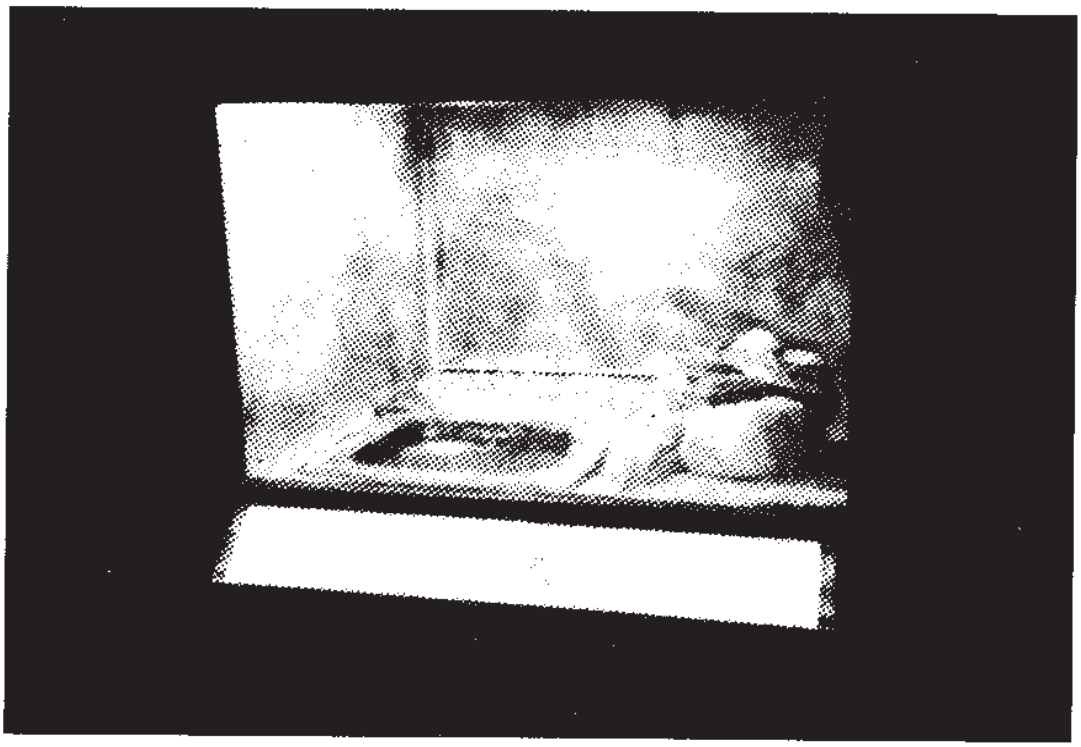

Fig. 5 — A living reptile at the Butantã Stop, Science Station, USP (Photo: M. Marandino).

[12] This exhibit was made in collaboration with the Museum of the Butantã Institute. The Butantã Institute is an important research and vaccines production institution in Brazil.

General Characteristics of Objects

The classification system for objects in museums of science and technology developed by M. Lourenço[13] was used as a basis to compare the collections in these four museums. According to this author, the division 'historical' *vs.* 'hands-on' objects – widespread among the 'milieu' – ignores the intrinsic functions of objects, making it more difficult to know them and consequently to present them in scientific exhibitions. Moreover, this dichotomy has consequences at the institutional level, reducing a complex and multifaceted institutional panorama to a mere 'museums' *vs.* 'science centres' viewpoint. Suggesting a 'back to basics' approach to the classification of objects in 'exact' science museums, Lourenço based her classification system on the purpose of design and construction (a parameter related to the function of objects). Lourenço consequently proposed three types of objects[14]: i) objects designed and constructed to teach science – 'pedagogical objects'; ii) objects designed and constructed for research in science – 'scientific objects'; and iii) objects designed and constructed to popularise science – 'popularisation objects'. Pedagogical and popularisation objects are similar because both have principles of simplification of reality underlying their design and construction. On the other hand, pedagogical and scientific objects also share

Fig. 6 – The exhibit 'The Drawer' (*Gaveteiro*), at the Science Station. Visitors are invited to open the different drawers where preserved specimens are kept (Photo: M. Marandino).

[13] M. Lourenço, 2000. *Museus de Ciência e Técnica – Que Objectos?* Unpublished MA thesis, Universidade Nova de Lisboa.
[14] Lourenço excluded technological objects from her study.

similarities because they underwent a contextual and functional disruption upon entering a museum – neither one of them was designed or constructed for exhibition purposes. In these three categories Lourenço found a place for models, scientific instruments, computers, hands-on, replicas, *maquettes*, and a wide range of objects familiar to most museums and science centres.

A particularly interesting feature of Lourenço's system is that it encompasses earlier and simpler systems, such as the one proposed by RIVIÈRE (1970-71). Rivière suggested that there were two types of objects in museums of science and technology: real things and models. Real things are those that we present simply as they are and models are simplified representations of objects, phenomena or concepts. Lourenço suggested that her 'scientific objects' resort in Rivière's category of 'real objects', while 'pedagogical' and 'popularisation objects' resort in his category of 'models'.

Although Lourenço's classification system does not include natural history specimens, her criteria were adapted to study the nature of the objects exhibited in these four museums of USP. These are common objects, present in many natural history or life sciences exhibitions, such as specimens, preserved organisms (or structures) by means of taxidermy, liquid preservation in flasks, complete skeletons or anatomical parts. These types of objects were present in all the exhibitions, with the exception of the exhibition 'Urban Birds' in the Science Station.

Frequently, mounted specimens are represented in dioramas, simulating natural habitats, as in the Museum of Zoology. The preparation of specimens in natural history museums is a long-standing practice and is usually performed by taxidermists. However, throughout the years new techniques have been developed. Naturalisation processes have the two-fold objective of preserving specimens and making them attractive, especially for exhibition purposes. Dioramas mark a clear disruption between collection and exhibition (VAN-PRÄET, 1995) and is an example of visitor-oriented approaches that started in the 19th century.

Other types of objects are frequent in bioexhibitions[15], such as plaster models of organisms cut into sections that allow the visitor to observe and learn about the internal organs, e.g. models of suids and bovids present at the Museum of Veterinary Anatomy. X-ray plates and slides with images of histological cuttings are also present in this Museum's permanent exhibition. Less common are *maquettes*, 3D structures representing habitats or presenting information. In the Oceanographic Museum, *maquettes* of marine habitats and food chains are on display. In this Museum, another type of objects is exhibited – instruments used in biological research and oceanographic expeditions.

A common feature in three of the exhibitions is the presence of living specimens. In the Oceanographic Museum, living specimens are kept in aquariums, offering an idea of the diversity of marine life. Live specimens are also present at the Science Station, in the exhibit 'Aquários' (one fresh water and two marine) and in the exhibit 'Parada Butantã'. In the latter, living specimens are presented in glass cases simulating their original habitat. However, some

[15] A word suggested by ROBINSON (1997) to designate exhibitions in zoos, aquariums, wildlife parks, marine-lands, botanic gardens, arboretums and natural history and anthropology museums.

remarks on the use of living specimens can be made. From visits and conversations with staff, some of the difficulties that living organisms in exhibitions present became clear. Issues such as the recruitment and formation of specialized staff, costs of necessary equipment, and the organisation of feeding and cleaning schedules represent extra concerns in these exhibitions. Another important aspect is the quality of life of the living organisms. The exhibition of living organisms presents technical, management, financial, and ethical challenges that have to be sensibly met with.

Through time, the nature of objects presented in bioexhibitions evolved towards a more didactical, i.e., visitor-oriented approach. This tendency became more evident with dioramas in the late 19th century. Aesthetical and informative elements on ecology and biogeography grew in importance and consequently exhibition specimens became substantially different from research specimens. The same visitor-oriented tendency can also be detected in the lesser prominence of 'natural' objects. In the Oceanography Museum and the Science Station, 'natural' objects fight for a space in the exhibition, among interactive apparatus, multimedia equipment and hypertext.

Adapting the classification system of Lourenço, some reflections can be made. On the one hand, some of the objects present in these four USP museums could be considered 'pedagogical objects'. Among these are the anatomical parts and the animal plaster models in the Museum of Veterinary Anatomy, especially prepared for teaching purposes. On the other hand, the majority of the objects seen in the Science Station fall under Lourenço's category of 'popularisation objects'. Furthermore, if 'scientific objects' are representative of the subject-based disciplines of museums of science and technology (e.g. Physics, Chemistry, Astronomy), then the same role is played by 'natural objects' in natural history museums. In all of the four exhibitions, natural objects were present, especially in the Museum of Zoology and the Museum of Veterinary Anatomy. 'Pedagogic objects', although less frequent, were present in the Museum of Veterinary Anatomy and sparsely in the Oceanography Museum – all institutions that incorporated university teaching collections. Finally, 'popularisation objects' were mainly seen at the Science Station and the presence of 'natural objects' and 'pedagogical objects' was minimal there.

Some reflections

Museums of the University of São Paulo are no exception to the statement of Warhurst (1986:138), that the "major impetus for university museum collections was surely to further the teaching and research responsibilities of the university". This role in teaching and research is clearly suggested by the history of the collections of the institutions included in this study.

As mentioned before, the Sertório Collection constituted the nucleus of the Museum of Zoology. On the other hand, the majority of the Oceanography Museum and the Veterinary Anatomy Museum collections were used by professors and researchers before they were incorporated. However, the Science Station is a special case because it does not have a collection in the traditional sense. The considerations explored here raise some interesting issues, particularly the question of 'what is a museum?', especially in the university context. Furthermore, they suggest some degree of subjectivity when the only criterion for the definition of a museum is the possession of collections. What is a collection and to what extent does a collection define a museum?

ABREU (1999: 14) suggested a typology to analyse USP's diversity of collections. From Abreu's point of view, USP has three types of museum collections. The first type, including the four USP major museums joined in the 'integration organ' (the Paulista Museum, the Museum of Zoology, the Archaeological and Ethnological Museum, and the Contemporary Art Museum) "follows a disciplinary model". The second type, directly related to USP Research and Teaching Units, encompasses teaching and research objects and is frequently used in classes and laboratories. The third type, also present in USP Research and Teaching Units, encompasses objects valuable to the history of the Unit itself, such as furniture, laboratory equipment, photographic and artistic documentation, personal objects from professors and researchers. These latter collections have an important role in the preservation of the memory of units and of the USP itself. Abreu also suggests that there are intermediate situations and that the differences and similarities between these collections can shed light on the relationships with the community outside the university. According to the USP assistant rector, these collections are instruments of dialogue between the university and society, and therefore essential to UPS' cultural outreach policies.

However, Abreu's classification might present some problems. First of all, all USP's collections are, in a way, 'disciplinary', reflecting the organisation of the university itself. In general, interdisciplinary museums are perhaps more difficult to find in universities than outside universities. From this point of view, it is difficult to designate as 'disciplinary' only a few USP museums. For instance, the four museums presented in this text have probably as much 'disciplinary' objects as other types of objects. Furthermore, the 'popularisation objects' predominant in the Science Station not only cannot be considered a 'collection' but neither do they fit into any of Abreu's categories. Finally, it results that if this collection-based classification has the purpose of defining USP cultural policies, then the Science Station should simply be excluded from these policies. It is interesting to note, however, that the Science Station, in the beginning, treated their hands-on objects as 'traditional' museum objects – they were inventoried and stored in specific storages. Although this policy clearly indicated a more general approach to objects, the practice was later abandoned. Regardless of these considerations, it is likely that other elements than the collections must be taken into account when defining these concepts and, consequently, when establishing policies.

This reflects a more general problem of classification that scientific museums have been facing, whether university museums or not. Although some typological proposals were already presented[16], there is no clear consensus on the topic. In the Brazilian context, M. X. Cury discussed differences and similarities between science museums and science centers, concluding that the principal difference lies in collections – they exist in the former and do not exist in the latter[17]. However, Cury argued that both share purposes and realms – public communication (and teaching) of science and

[16] BRAGANÇA GIL (1988, 1998) proposed a classification based on a historical approach, and expressed it in three generations. MCMANUS (1992) also identified three generations of scientific museums, according to the themes behind their conception, also based on history. J. Padilla defended the existence of an evolution in the traditional museum concept and proposed a typology based on the communication strategies chosen to approach the public, suggesting four generations for scientific museums [J. PADILLA. Museos y Centros de Ciencia en México. Unpublished paper presented at the *50a Reunião Anual da Sociedade Brasileira para o Progresso da Ciência*, Natal, Rio Grande do Norte, 1998].

[17] M. X. CURY. *Estudo sobre Centros e Museus de Ciências – Subsídios para Uma Política de Apoio – Relatório Sintético*. Consulted in www.publicabrasil.com.br, São Paulo, 2000. This report was commissioned by the Vitae Foundation, which was interested in promoting scientific education in Brazil. The document tries to identify and study the principal features of Brazilian science centres and museums.

technology, acting in the informal education field and frequently using similar strategies. Nonetheless, she adds that different working methods, different activities developed, and different approaches mainly derive from the existence or non-existence of collections. This study, which identified the majority of science and technology public communication institutions in Brazil, considered a science centre to be one type of museum.

These concepts have been repeatedly discussed in papers and professional meetings. The question 'what is a museum of science?' was discussed in the 2000 CIMUSET[18] meeting in Paris. Several directors of museums of science and technology were present (mainly from Europe), as well as associations of science museums' professionals from all over the world. In the debate, it was mentioned that current museums' definitions have a strong focus on collections, and often institutions do not want to be designated museums because, for them, museums are 'boring' and unattractive to the public. As could be expected, no consensus was reached.

USP's scientific museums suffer from all these clarification problems as well as from other problems that derive from the fact that they are university museums. The triple crisis – of identity, recognition and resources – identified two decades ago by Warhurst (1986) in the English university context, seems to occur also in Brazil. These problems are perhaps even more acute in the university museum context. Like in many university museums, the collections derive from the use of objects in teaching and research and sometimes only a few people inside the university seem to acknowledge their patrimonial value and the need to make them known to broader audiences. Exhibition working teams are more and more concerned with museographic aspects such as layout and labels, in order to improve the effectiveness of communication. The increasing number of visitors, especially school groups, creates the necessity of providing more explanations that are simultaneously attractive. For instance, the introduction both of extra information and interactive anatomical objects in the Museum of Veterinary Anatomy are clearly an indication of this trend. Another meaningful example of this effort is the development of activities capable of directly involving audiences, such as the 'Ecological Expeditions' programme offered by the Oceanography Museum to school groups. Initiatives of this sort represent a clear sign of the educational concerns of museum teams, in spite of the lack of financial resources. Furthermore, recent organisational and administrative changes in some institutions also point in the same direction. For instance, the Museum of Zoology recently created the Cultural Diffusion Section, with two sub-sections, Educational Activities and Museology, with the aim of improving educational aspects in the exhibitions. As far as the Science Station is concerned, the fact that its creation was inspired by the science education movement in Brazil inspired from the very beginning a stronger focus on educational aspects. Actually, the mission of the Science Station was to promote science education and its diffusion to the general public through interactive exhibitions.

The scientific museums of the University of São Paulo, although in different ways, are improving their mechanisms of public communication and establishing fruitful dialogues between the university and the public. University museums can be, in a

[18] CIMUSET is the International Council of Museums' Committee for Science and Technology Museums.

unique and fundamental way, instruments to link knowledge and society. In order to establish clearer political and cultural action, universities should take into account the diversity and specificities of their museological collections. Moreover, they should face the challenge of harmoniously associating teaching and research activities with museography and exhibitions. In order to meet this difficult challenge, a closer look of what is already the practice in some museums is required. An inclusive cultural policy, not excluding those institutions that do not have collections, should therefore be sought. Finally, and although university museums still need to specify their identity – especially in view of 'the crisis' – they should also be understood in a broader museological and historical context. On the other hand, universities ought to be more aware of the role their museums can play in bridging knowledge and society.

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081 THE ROLE OF SCIENTIFIC DISCOURSE IN BIOEXHIBITIONS PRODUCTION

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Abstract:

This paper is the outcome of a PhD thesis produced at the School of Education of São Paulo University and studies the transformation process of scientific discourse - particularly the biological - into expositive discourse in the construction of science museum exhibitions. The methodological approach was based on the principles of qualitative research. Five exhibits were selected from the following museums: Zoology Museum, Veterinarian Anatomy Museum, Oceanographic Museum, Science Station, all belonging to the University of São Paulo (SP), and the Museum of Life – Biodiscovery Space of the Oswaldo Cruz Foundation (RJ). To understand the construction of the expositive discourse, we used the studies carried out by Basil Bernstein (1996) in the field of educational sociology. Also, others authors, related to museum communication and to the concept of didactic/museographic transposition were used. Based on the articulated study _ of the history of Biology and _ the history of museums, the exhibits were described and their constitutive elements such as texts, objects, the relationship between collection, research and exhibit, the discourses present and the role of the biological discourse in the formation of the expositive discourse were analysed. The results suggest the necessity of going deeper into the question regarding the production of biological knowledge, its history and epistemology. The introduction of biological phenomena in science museums raises questions about the particularities of this type of knowledge and may contribute to the understanding of these particularities in teaching and broadcasting.

I - Introduction:

This article is the outcome of a PhD thesis produced at the School of Education of São Paulo University and studies the production process of science museums exhibitions, i.e., the transformation process of scientific discourse - particularly the biological - into expositive discourse. The characteristics of the various discourses and areas of knowledge that participate in that process were described as we identified what happens to scientific knowledge when is to be expressed in bioexhibitions.

References from the areas of education, scientific divulgation, communication and language, in addition to the works on museology as well as on the history of biology and science museums provide theoretical basis for the study. As such, it focuses on understanding what happens to scientific knowledge when it is presented in museum exhibitions treated as pedagogical entities.

The methodological approach was based on the principles of qualitative research. Five exhibits were selected from the following museums: Zoology Museum, Veterinarian Anatomy Museum, Oceanographic Museum, Science Station, all belonging to the University of São Paulo (SP), besides the Museum of Life – Biodiscovery Space of the Oswaldo Cruz Foundation (RJ).

In this work, we present part of the data from the research related to the role of the biological discourse in the construction of bioexhibitions.

II – The Studies on Transposition and on Recontextualization of Scientific Knowledge: A Brief Synthesis

The transposition of scientific knowledge to other social arenas has increasingly been the theme of studies in educational and scientific broadcasting areas. Researches in Education have been defending the idea that "scientific knowledge and the knowledge acquired in school lies on different learning spaces and school disciplines hold a different epistemological and sociohistorical background than scientific disciplines" (Lopes, 2000:150). Among other implications, this idea recognizes the existence of a "school culture", with the school as "also being a true producer or creator of cognitive configurations and original habits" (Forquin, 1993:34).

Chevallard (1991), for instance, introduces the concept of didactic transposition stating that "Knowledge-as-it-is-taught, the taught knowledge, is necessarily distinct from the knowledge-initially-designated-as-being-the-knowledge-that-must-be-taught, the knowledge to be taught." (Ibid., p.17). According to Chevallard, the knowledge contents designated as those to be taught are true didactic creations, caused by the educational needs and go through a collection of adaptive transformations. The work involved in transforming a subject of knowledge to be taught into a teaching subject is what he calls "didactic transposition".

Other authors have been working with the concept of didactic transposition and there are indications that other elements than the wise knowledge - as, for instance, the social practices, are references for the construction of school knowledge (Astolfi and Develay, 1990; Caillot, 1996).

Regarding the subject of didactic transposition in museums, the work by Simonneaux and Jacobi (1997) stands out, since they propose the notion of museographic transposition based on Chevallard's work, to describe the transposition of the acquired knowledge into a knowledge to be displayed in exhibitions. Also, we used works about museum communication from Davallon (1999).

Another important reference for the comprehension of the process of translating scientific knowledge are the studies carried out by Basil Bernstein (1996), in the field of educational sociology. This author goes further into the subject of the construction of pedagogic discourse, stating that "pedagogic discourse is a starting point for seizing other discourses and putting them in a special mutual relation, aiming at its conveyance and selective acquisition". As such, to Bernstein (1996:259) "pedagogic discourse is thus a principle that removes a discourse from both its practice and context and relocates that discourse in accordance with its own focusing and selective reordering principles". Thus, the constitution of the pedagogic discourse implies a *recontextualising* principle that selectively appropriates, relocates, refocuses and relates other discourses in order to make up its own order and orderings. Bernstein's work helps us to better understand the process of creating the pedagogic discourse. If we regard museum exhibitions as pedagogical entities and the expositive discourse as a kind of pedagogic discourse then it is essential to consider that this discourse *recontextualised* other ones, including the scientific.

III – From Natural History to Biology: Walking through the History of Science Museums

The knowledge stemming from the field of biology has long been the subject of science museums exhibitions. Natural History Museums began serving the purpose of collecting, preserving and studying specimens that allowed the systematic investigation and research of nature (Gil, 1988:72). The so-called "Curiosity Cabinets", originated in the 16th Century, gathered heterogeneous collections with samples from nature, historical items and antiques and had their role slowly changed, in an attempt to "replace their old displays by catalogued exhibitions which became a way to introduce 'an order of the same character established among the alive' in the world's conceptual definition and, thus, offering another way of making history" (Lopes 1997:13).

Some milestones were essential in the development of these museums throughout their history. The modern origin of Natural History Museums can be represented with the French example of the *Museum National d'Histoire Naturelle* (1793), the first modern museum of this kind, (Gil, 1988:75), although it has a long history. In the end of the 19th Century, Darwin's work was another milestone in the history of these museums, since: "(...) it produced a decisive evolution in the Natural History Museum's concept and objectives which developed from mere galleries for admiring curiosities into institutions that, apart from broadcasting natural knowledge, play the role of research institutes with the aim of promoting the methodical exploration and systematic study of nature." (Ibid.).

Influenced by Moebius' theory a new transformation takes place in these museums. This theory "is based on the principle of a clear separation between a scientific collection (for research purposes, therefore as comprehensive as possible) and the one which is put to public display, based on the latter but carefully organised and displayed with its most representative items, or their accurate replicas, for a convenient and fruitful approach of the treated subjects by non-specialists" (Idem.).

Natural History Museums have developed throughout the years and are still constituted of collections that highlight scientific research. However exhibitions are becoming more and more important, increasing the use of the resources of modern museology.

On the other hand, Science and Technology Museums have also developed in the history of museums, also with important milestones that help understand contemporary science museums. The origin and aims of these museums are different from those of Natural History, since they were from the beginning "created with essentially utilitarian objectives" (Gil, 1988:77). One may, however, state that this utilitarian aspect depicted a gradual concern with showing scientific and technical evolution to the public and this has become one essential element of these museums.

The 20th Century thus inaugurates a new type of museum in this field, the so-called *Science Centres*. These museums are originated with the "perception of the imperative educational needs, attempting to revolutionise its teaching methods through observation and experimentation" (Ibid., p.80). Such institutions are firmly gaining space within society and among the several transformations they have been going through, some stand out: those most recent ones, related to their perception of the role of the public, since these museums were the ones to have found, through educational activities, a new way to regard the relation between visitor and displayed object.

Another way to perceive the history of these museums is indicated by Cazelli et al. (1999), based on the work produced by McManus (1992). Science Museums are thus characterised by the themes that initiated them, that is: a) the first generation ones, i.e., the Natural History Museums; b) the second generation ones, where emphasis is put on the world of labour and on the aspects related to science and industry; and c) the third generation ones, centred on scientific phenomena and concepts. To Cazelli et al., this third generation of science museums encompasses the concern to improve education and holds a central focus on scientific phenomena and concepts. At the same time, in these museums the communication between visitors and science is mediated by a stronger interactivity with the different displayed devices and the role of the visitor in the learning process is emphasised.

However, the perspective of interactivity in museums only recently has been argued (Gil e Lourenço, 1999; Falcão, 1999). It is, for instance, stated that the *hands on* type of interaction does not necessarily guarantee an intellectual engagement. Another criticism concerns the natural identification of the interactive expression with Physics, turning the application of this type of communication in fields like Chemistry and Biology a much harsher task to undertake. Besides that, the lack of concern with the historic-cultural dimension and with the scientific processes, their history and their implications in the social context are also argued.

Regarding Biology, its constitution as a discipline as we know it today is relatively new. Since its birth in the 19th Century, this area of knowledge has been kept in separate parts for a long period of time and according to Smocovitis (1992), the proposition of the Evolutionary Synthesis in the 30's, was a key factor for its unification. The autonomy and even the idea of a unified Biology are not consensual among epistemologists and science historians (Jacob, 1985 in Wortmann, 1994). However, the changes occurred in the field of Biology towards becoming a scientific discipline and the discussions related to the questions on Biology and Society as well as on Ecology and Environmental Crisis have also been influencing the conception of Natural History Museums. Brown (1997:39), for example, argues that the present role of these museums vis-à-vis the innovations in biological fields, such as the development of modern genetics, and proposes a new way of *collectionism* that is able to meet the planet's needs. Other authors have been raising the questions associated with the impact of the new research perspectives in Systematic and in Modern Biology in defining the role of museums (Mayr, 1988; Erzinçlioglu, 1993; Brandão, 1999).

As such it is possible to say that the particularities of the teaching/broadcasting and learning processes in science museums have been pointing at the necessity to consider the results produced by research in this field in the preparation and evaluation of both the exhibitions and the cultural and educational activities in these settings. One may thus say that for the elaboration of bioexhibitions in science and natural history museums

today, aspects concerning the history and structure of the biological knowledge as well as the incorporation of the educational and communicational references must be considered. Questions pertaining to the relations among scientific research, collection, assets and display, as well as to aspects of management and administration, also influence the conception and construction of the expositive discourse.

IV – The Construction of Expositive Discourse: Some Considerations

Based on the articulated study of the history of Biology and the history of museums, the exhibits from the research were described and their constitutive elements such as texts, objects, the relationship between collection, research and exhibit, the discourses that were presented and the role of the biological discourse in the formation of the expositive discourse were analysed.

Taking in account the data obtained in the research, three items were discussed. The first refers to the educational and communicational perspectives of the exhibits. A second aspect relates to the 'game' taking place in the expositive discourse constitution: the expositive discourse has a behaviour similar to Bernstein's pedagogic discourse, for it displaces other forms of discourse based on its own principles and objectives and assumes the characteristics of the "recontextualizing" discourse. Nevertheless it is worthwhile observing that the expositive discourse has specific characteristics different from the school pedagogic discourse, which results from the relationships between time, space and the objects in the museums with direct implications upon the evaluative rules of the discourse constitution. It is postulated that the expositive discourse constitutes a specific discourse, since it has its own objectives and it arranges other discourses according to its own logic, it behaves similarly to the pedagogic discourse.

Finally, modern questions on the issue of biology exhibitions in museums were discussed. After an analysis of the role of the biology discourse in the making up of the expositive discourse, challenges, limitations and possibilities that the biology area must impose in order to be presented, were discussed. Various perspectives were suggested aiming at presenting Biology in museums.

In what concerns the biological discourse in the constitution of the expositive discourse, some elements will be pointed out. From the point of view of the studies about the history of biology and the history of the museums it is possible to affirm that the presence of authentic objects, scientific and natural, as conserved beings, fossils, living creatures, etc. marks the legacy of Natural History and its role as a science at a time where the Museums of Natural History were the main centres of production of knowledge in this area. At this moment, more than understanding biological concepts, it is necessary to present natural sciences, its discourse and its logic so that the exhibits show the systematic and taxonomic organization of living creatures. That perspective considers the object the main element. On the other hand, with the sprouting of dioramas in the Museums of Natural History and, later, the increase of the use of the devices, models, rejoinders, etc.. in Museums of Science and Technique and the Science Centres, such objects had clearly more didactic objectives, related to the presentation of the concepts to the public.

As _ mentioned before, Natural History had been through deep modifications in its growth, mainly with the Theory of the Evolution. Recently, Biology became an autonomous discipline, although there is no consensus in the debate on this subject. This new picture also brought new contents, especially in Genetics, Molecular Biology, as well as Ecology. Other challenges appeared to the exhibition development at museums.

The final of the 20th century is strongly marked by the questioning of the objectives of the Natural History Museums and one of the quarrels is to which thematic choice these museums must be dedicated today. Many defend that the Natural History Museums must give priority to environment problems, since these possess a high level of penetration in the society and influence some aspects of the human life and all beings of the planet. On the other hand, some scientific researchers from the Natural History Museums criticize the perspective of assuming a thematic body _ in the displays that is not connected with the research in Biology developed in the institution. In these cases, the exhibitions would have to present the research in Zoology and Botany, mainly in the aspects related to Systematic and the Evolution, but also in Ecology if it is a subject of research in that place.

Moreover, the more the conceptual proposal is centred on the mediation with the public, the recontextualization process is more evident and more discourses can be part of the negotiation. On the other hand, the more the exhibition conception is centred on information and its transmission, the recontextualization process, with few discourses in play, will privilege one or few discourses, often prevailing the logic and the structure of the scientific discourse.

V – Conclusion:

The present study seeks to understand the construction process of the expositive discourse based on the idea of the recontextualising redefinition of the scientific discourse takes place when it is transposed to science museums exhibitions. However, all evidences point towards the fact that scientific discourse is not the sole responsible for regulating and determining this construction. Other discourses could be an active part of this process and, according to the conception adopted in elaborating the exhibition, these other discourses may be more or less intensely expressed in the expositive discourse.

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