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On how science becomes culture: the case of Corunna*

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I will focus on the science-education-culture triangle and on the components which I consider to be most important from my personal perspective and experience, an experience which I will summarize as (1) a science teacher in the classroom, covering all educational levels, from pre-school to university between 1969 and 1983, (2) my work in science museums organizing expositions, audio-visuals, educational activities and resources between 1985 and 2001, (3) my articles and conferences on the popularization and the teaching of science between 1972 and 2005, and (4) my relationship with science since 1947.

In the fields related with our work and in the media we often hear about scientific literacy, culture and education, although little about what these actually mean. It is frequently said that it is necessary to possess a scientific culture to better participate in political decisions and to reduce superstition, among other things. The truth is that the main reason is a humanistic one. We need to be educated individuals, to understand ourselves and our environment, and from this derives the need to include science in what we understand as culture in the broad sense.

Examples of how science becomes culture in a highly subtle or natural way are very close to us. People learn science in very different ways and situations. A mushroom enthusiast knows a lot about the ecosystems where these are found, and the same can be said for many jobs and scientific-oriented interests, from fossil collectors to cooks, with anything from fishermen, gardening enthusiasts, bikers, hackers or amateur astronomers in between, all of whom end up accumulating a great deal of practical science. This should be considered in order to overcome the distance that exists between the academic science taught in school and that learned in everyday life.

The immediate achievement of a basic scientific education would be for the individual to feel comfortable with his or her environment, a sensation derived from the knowledge and understanding of our world's basic processes, and thus comprehension of the pros and cons of every individual or collective action on the environment.

Every once in a while we read poll results which try to measure the citizens' level of scientific culture. That a majority of these surveys are almost exclusively based on school programs can make us doubt the results. The average citizen today knows much more science that at any other given time in history and is continuously encountered with leaning situations. Among the reasons which motivate us to want to learn we can mention:

Health. Both our own diseases and those affecting our relatives and close friends, have taught us a lot about our body, and our concern about health is probably the main reason for which we acquire scientific knowledge. That is how we learned, for example, where the mediastinum was, a little bit on metabolism, about different types of lymphomas and the causes of herpes.

Prevention. This natural concern for health becomes manifest in prevention, in an attitude of alertness towards possible aggressions from the environment. The search for safety leads us want to know more about our surroundings. The effects of ecstasy, nuclear waste, floods, mad-cow disease, aerials of mobile telephony, are examples of topics commonly present in communications media and are the result of the public's interest.

Usefulness. There is some knowledge which we automatically incorporate when using the new products and appliances that invade the market. The active *Bifidus* or preservatives, the consumption of Norlevo or Viagra, the handling of equipment (microwave ovens, DVD players, interactive television) or the use of computer anti-viruses, are some examples.

Curiosity. Why does the Sun move? Where do children come from? Where does the water go when the tide goes down?

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What do frogs eat? Since an early age, we discover the world through questions and finding someone who can answer them. Some times we do it by observing nature and our environment, some others by looking things up in books or asking a teacher, our parents, etc.

Fun. In a society where leisure is becoming more and more important, people invest more dedication and effort in hobbies, making it sometimes difficult to distinguish between the enthusiast and the expert. Through sports and activities related to nature (amateur astronomy, bird-watching, etc.) or technology (computing, photography, scale models, etc.) we learn about anatomy, meteorology, electronics, chemistry or biology, among others.

Responsibility. Our sense of responsibility, both individual and collective, for the environment has increased thanks to information coming from different sources, especially television. We become aware of processes such as the greenhouse effect, climatic change, deforestation, loss of biodiversity and ecological disasters among others.

School. Obviously, there is also "compulsory" learning. Theoretically, in school we should acquire the knowledge, habits and attitudes that will allow us to adapt throughout life to the changing reality of our environment. I personally doubt that many will achieve that goal, but in either case, the school curriculum provides a certain amount of scientific knowledge, some of which may even be useful. I will discuss this aspect later, since the area of education is of vital importance.

Signs of a scientific culture

The consulted bibliography proposes the following as signs of scientific culture:

1. Reading and understanding science articles and news in newspapers, graphics displaying scientific information and making valid deductions and predictions.
2. Well-informed participation in the discussion of current topics (e.g. human cloning).
3. Applying scientific knowledge to decision taking.
4. Knowing how to find scientific information when needed.
5. Knowing how to carry out experiments to compare ideas and how to express these.

Effects of science on culture

Bertrand Russell stated that traditional beliefs, such as witchcraft, would disappear thanks to science, and be replaced by others suggested by the scientific method. He also pointed out the obvious effects of science in industry and war, the social and political changes it leads to, and the newfound control over the natural environment which would result in a philosophy where the man's position in the universe changes.

There are two examples of how progress in science changes even the most profound ideas and established behaviors. One is the concept of death. When my grandparents died, I remember hearing that we should take the pulse, listen to the heart, put a mirror next to the face to see if it would steam up… death then, was equivalent to cardiorespiratory stop. It now comes defined by the encephalogram which when flat, indicates a corpse from which we can remove the beating heart for transplant, for somebody else to use. Another example is the Internet, which allows for two people to exchange thoughts and ideas, to become intimate and know each other before actually meeting or hearing each other for the first time. The traditional process of falling in love (and mating?) whose starting point revolved around the physique becomes altered.

Values in science

What values does science provide to culture? These are some in my opinion.

Curiosity. Because, above all, science is a wish to learn and understand, which can become manifest in many ways, such as the search of data and its meaning.

Skepticism. Science promotes the search of proofs and the continuous evaluation of knowledge. A scientist questions all. The value of honesty is also included here.

Rationality. By this we understand a respect for logic, and the consideration of the antecedents and consequences of every phenomenon analyzed. It is the search of causes and reasons of each event. A rational person is not superstitious.

Communism. The fruits of science, scientific knowledge, belong to all humanity.

Provisionality. It is an essential characteristic of scientific knowledge which opposes the preconceptions of certainty, permanence and immutability. This is, without doubt, a critical point, since uncertainty is always difficult to accept.

Criticism. Science is critical with itself and should be exposed to social, historical and cultural scrutiny.

Openness. It is the willingness to accept new ideas and proposals and to change our own according to evidence. An open attitude in science is essential for creativity to flourish.

Creativity. It is essential to establish original relationships, design experiences, propose hypotheses, invent laws, models, theories, apparatus and much more.

Science induces a way of thinking. It raises questions and the ways to answer them. Science is an instrument to explore that which can be proved through observation and experimentation. We can identify some signs: attitudes, methods and tools.

Scientific attitudes: the five C's

Attitude is what essentially changes less. Concepts and theories evolve; tools and mediums change. What remain unchanged are the values of science with respect to logic, skepticism, etc. For this reason, we say that someone is scientifically-minded when they show curiosity, criticism, constancy, creativity and care towards humanity towards planet Earth.

Education, what for?

Ideally, education should provide the guidelines for a personal re-elaboration of culture, a preparation for life. But if "education is what remains when we have forgotten all that we have been taught" (cited by Albert Einstein in "Out of my Later Years"), then scientific education should include skills, techniques and habits for scientific creation, in order to view the world objectively and with a capacity of prediction which would lead to raising questions and trying to resolve them through observation, description and measurement. Education should incorporate the design and carrying out of experiments (using apparatus, making hypotheses, proving or disproving those hypotheses), reaching conclusions, and applying creativity to solve problems. It should also value and thus stimulate the capacity of communication, both written and spoken, and help to interiorize that the concepts used by science are human inventions and not unchangeable truths.

A key point is to be able to put scientific knowledge into the context of different fields and situations. In everyday life this includes work, cooking, uses of appliances, body care, nutrition, animal care, laundry, games, diversions, etc. With regards to scientific information it implies understanding and interpreting environmental, health and technology news, etc. In other aspects of culture it means trying to relate it to history, philosophy, economics, politics, religion, technology, art, etc. But perhaps the main objective of science as culture is to provide a sense of happiness, hope and intellectual competence; and to generate enthusiasm for knowledge about the universe.

Another thought comes to mind when speaking of knowledge: Is there "essential" knowledge in science? For over ten years I participated as a instructor in courses for the teaching of sciences. Thus, I was able collect data about the objectives and interests of professors all around Spain. Casually, at the beginning of many seminars, I would ask teachers the following question:

"You are elementary school teachers in the area of Sciences. You are responsible for the scientific culture that a group of people will develop in the educational system that our society demands and offers. In that context, point out five things that are essential for a student to know, once he finishes his education, in the field of sciences; those which you consider serious for them *not* to know after eight years of schooling." Throughout those years, I collected answers from more than 1800 teachers. In 70% of the cases, the Archimedes' principle was mentioned, and in the first place for many of them. Do today's teachers feel or think the same way? What does knowing Archimedes' principle imply?

Some reasons for an unsatisfactory situation:
Many of us are not satisfied with the education offered in science in our country because it does not contribute to science becoming culture.

1. Reasons of cultural tradition
Throughout our history there has been scholastic fervor for Plato, but we have been without a Francis Bacon. Maybe the lack of a tradition for scientific and technical thought in Spain is related to the weaknesses of the scientific aspects in its educational design. Also—in occidental tradition generally—science has been studied independently of its social implications, of its interaction with the history of ideas and other aspects of culture. It is sad that science is offered as an alternative of humanities.

2. Errors in the education approach
In formal education, there is no point in maintaining the same curriculum approach that was used back when it was possible to condense all the knowledge of the past. Surveys given to 406 teachers in 114 schools in La Coruña (1998) showed that 81.3% used textbooks as a key element and as a guide to teaching. "Practical activities" did not exceed more than 10.4% of the cases, and of these, 60.2% were used to "strengthen learning" and 17.5% as a method of evaluation. The development of methodological techniques or aptitudes was barely mentioned.

At the same time, in both school and society, science is shown as an objective truth that should be accepted (without realizing it we go from the authority of Aristotle to that of Newton, and we still think in terms of authority). Students are invited to school to write and paint (regardless of whether their essay will ever be published or their painting end up in any museum), but they are never asked to formulate a hypothesis, to identify the variables of a process or to elaborate a theory. In this way, a person cannot feel science as a human creation that can be understood and created by any of us.

Perhaps we should admit that the knowledge an average citizen needs in order to have solid opinions on a certain topic related to science can be above the real possibilities of the population. But even with this and other objections, we should remember that one of the most important objectives of teaching sciences is to demonstrate the effectiveness of rationalization in processing topics, which helps to overcome emotional approaches. The practice of the scientific method offers an unbeatable resource for independent critic, based in the acceptance and necessity of a respect for logic.

Current trends in the teaching of science

In the last years we have observed the following: (1) School is no longer considered the only place for learning. (2) The authority of books is now shared with communications media. (3) Information sources include teachers and professionals of communication. (4) A closed curriculum, necessary and equal for all, lead the way to a different one, where learning is based on each person's own curiosity. (5) An extension of the period

of learning; you continue to learn throughout life. (6) Knowledge has changed from being thought of as lasting and stable, to being considered as changing and provisional. (7) Interdisciplinary approaches instead of academic disciplines.

Obviously, all these changes do not imply the extinction of the current school system, but they entail a profound restructuring.

As a conclusion to my Decalogue on scientific education, I believe that it is from teaching and education from we can best contribute to science becoming culture.

1. Integrate knowledge and discoveries

When pupils are young, they should be subjected to situations in which they discover the largest possible amount of things through experience. Later, little by little, they will intuit that the rest of knowledge they acquire was obtained by other people following similar methods. Knowledge does not fall from the sky.

2. Promote other means of learning

Children, like adults, learn a lot of science outside the classroom: in television, in car magazines, in the news, in museums, etc. This then means that newspapers for example, should be taken to the classrooms… and children to museums…

3. Include students' own questions

One of the biggest problems in schools is the lack of respect for students' questions. When a small child begins primary, he is already full of questions. I had them as well. Many have heard me tell that one of them was "Why do dogs lift up their leg to pee?", and I still haven't got it solved. In school they did not listen to me; they ignored my questions, as is common when regarding children.

4. Ask in order to teach

Teachers almost always ask to evaluate. They ask what is already known, reinforcing the idea of an authority that evaluates and penalizes. Although this may be necessary up to a certain point, it is important to ask questions that encourage a critical spirit and scientific thought: How do you know that? Where and how did you obtain the proof? What is the uncertainty of your results? Has the experience repeated itself many times? How could you confirm your conclusions? Is there someone who does not agree with you? Why?

5. Diverging questions

Converging questions—what is the annual rainfall in Valencia?—have a single answer, are useful to examine or conclude, but rarely lead to investigation. Diverging questions on the other hand—what changes could take place in Valencia's landscape if rainfall was to duplicate during twenty years?—are open, can have various valid answers and frequently lead to an interest in knowing more on the subject.

6. Promote scientific attitudes

There are many ways to do this, such as encouraging curiosity, rewarding creativity, incorporating skepticism, avoiding dogmatism and valuing perseverance.

7. Incorporate scientific language to everyday language

It is important to understand scientific terms without fear, because only a few are indispensable. To memorize technical vocabulary makes no sense. Many times I have met people that know that DNA stands for deoxyribonucleic acid, but this word holds no meaning for them. Education should provide experiences of authentic scientific communication.

8. Integrate aesthetic answers

The reason for the sky being blue, understanding the evolution of stars or how the heart works does not mean that the artistic or poetic knowledge of these phenomena should be disregarded. Scientific knowledge does not take away anything from culture, if something, it adds to it. Furthermore, it opens new fields for aesthetics (diffraction, macro photography, creation in engineering, scale modeling). Ramón y Cajal once said:

"The garden of neurology offers the researcher captivating spectacles and incomparable artistic emotions. My aesthetic instincts find their full satisfaction. Like the entomologist catching colorful butterflies, my attention pursued, the garden of the grey matter, the delicately and gracefully shaped cells, the mysterious butterflies whose wings beats might some day reveal the secret of mental life".

9. Integrate historical, social and economic perspectives (CTS)

Many scientific ideas should be presented in their historical context to favor the critical sense and to think about the provisionality of knowledge. Capturing society's and culture's influence in the development of science and technology is important. Students must start to comprehend the factors which nowadays determine the organization, financing and control of science.

10. Provoke the experience of scientific creation

Propose hypotheses, use instruments and tools, and ponder on questions such as: how many times does a ping-pong ball bounce before stopping? What is the average speed of a fly? How long does it take for a liter bottle to become empty? How many intelligible words can be said in a minute? What is the minimum distance an athlete running the 100-meter dash, needs in order to stop? What is the temperature of a candle flame? And also, what variables influence the number of spectators at a football match, the number of leaves that fall off a tree every day, the speed of snails, the number of students which arrive late to class, the weight of an orange, the cooking-time for chickpeas, how long the tires of a car last, the number of flowers a geranium produces in a year?

11. Procure personal implication

Even by provoking or disturbing the personnel: A problem of eggs. Ms. Rocío cooks marvelous cakes at home, which she later sells to the town's bakery. To make them, she uses a great deal of eggs weekly, which she buys at the supermarket. There she can buy the big ones, at 2 euros the dozen, o the medium ones, at 1.5 euros the dozen. She does not know with which type her cakes would be cheaper to make. She goes up to her grandson Federico, a scientist, for help, and waits for the answer.

I now want to talk about the experience undergone and achievements obtained in an attempt to make science become a part of culture, by referring to the role of science museums, and in particular to the model of Corunna, of which I am especially proud.

The new Science Museums in Corunna

Twenty years after the creation of the House of Sciences in Corunna, everything indicates that its consolidation has taken place in every aspect. Many are those who do not even remember or imagine the city without this institution, and the creation of the Domus confirms the success of these initiatives. Both centers have become an international reference of the city, at least in the scientific and educational milieus. In Galicia, the House of Sciences is a place that students are by duty bound to pay a visit to, and if we consider the Spanish prospect, it should not be overlooked that this institution has served as a model for the creation of most of the other existing ones. During this time, the interest towards these types of installations has increased in various cities around the world, thanks to the changes in the social considerations of science and the recognition of a necessity for scientific education.

Twenty-five years ago there was not a single science museum in the modern sense in Spain, and only two science centers in all of Europe: the Evoluon, opened by the Philips firm in Eindhoven (Netherlands) and the Palais de la Decouverte (Paris). The classical Science Museums in London, Munich and Milan, had neither the interactive nature nor the conditions that characterize the new museums nowadays. This was also the in Spain with the National Museum of Natural Sciences and the Science and Technology Museum in Madrid, the Geology or Zoology ones in Barcelona, or other smaller ones, usually linked to university centers, which together did not reach 300000 visitors a year.

Curiously enough, innovation in science museums in Spain had its origins in the European Renaissance, with the creation of the Museum of Science in 1980 and of the House of Sciences in 1983, which would open to the public in 1985. Although the Evoluon closed before that, the Cité des Sciences et de l'Industrie, Paris, and the Launch Pad of the Science Museum in London, were inaugurated in 1986. The Laboratorio dell'Immaginario Scientífico in Trieste and the Teknikens Hus in Sweden followed in 1988; in 1989 the Heureka opened in Finland and the Eksperimentarium in Denmark in 1991. Nowadays, science museums in Europe can be counted by the dozen, and are flourishing in Spain as well.

Since the beginning of the 1980s, Science or Planetary Centers have been created in a dozen Spanish cities (Barcelona, Corunna, Madrid, Pamplona, Castellón, Alcobendas, Granada, Tenerife, Cuenca, Las Palmas and Seville) and given the success among the public, there are projects that guarantee that this trend will continue. In all cases, it involves regional or municipal initiatives.

The birth of the House of Sciences

In 1976, I had the opportunity to work with James Rutherford, author of Harvard Project Physics, advisor to President Carter and former director of Education at the AAAS (American Association for the Advancement of Science), in the Project City Science of the New York City School District. One of the program's objectives was to promote the use of civic resources for the teaching of science.

On December 1977, Jim Rutherford came to Corunna. We were contemplating the abandoned palace in the Santa Margarita Park one afternoon when he became interested in the origin and fate of that edifice. I tried to explain to him in general terms the vicissitudes I knew about the place, setting of many of my childhood games. I told him the rumors I'd heard, and the things people said, like that in the mid-fifties, the place had served as a summer retreat for General Franco; the talk about the possible construction of a restaurant with windowed balconies or the regional headquarters of the Spanish National Radio, which already happened to have its antenna in the park, that it might serve as the first headquarters for Galician television or as a Palace of Congresses, a conference room, etc. Then, with a naturalness that I could not understand, Rutherford asked me, "And why don't you propose the mayor to build an interactive science museum here?" That question was incomprehensible to me. Not only were there no precedents of that type of museums in Spain, but back then, before the first democratic elections of the city council, a mayor would not receive a citizen's proposals that easily.

In 1981 we saw how in Barcelona, Spain's first interactive science museum opened its doors. It used San Francisco's Exploratorium as a model, and belonged to the 'La Caixa' Foundation. I do not know if we can talk about serendipity, but five years after Rutherford's question, municipal elections took place, and on the PSOE's (Spanish Socialist Worker's Party, lead by Francisco Vásquez) electoral leaflet for Corunna, appeared the objective to "build a museum of science and technology". In June 1983, Vásquez became mayor of the city, and in December of that same year, the first steps were taken to convert that building in the Santa Margarita Park into a "Science Center" that would be called the "House of Sciences". A planetarium would be installed in the dome, and the cannon on the spiral staircase would hold a Foucault pendulum. The need to find somewhere to place the collection of naturalist Víctor López Seoane, which was kept in city hall's basement, helped to justify the initiative, since it was not easy to explain, even to the municipal corporation, what exactly an "interactive science museum" would hold.

Twenty years of experience

On 1 June1985, the king and queen of Spain inaugurated the House of Sciences of Corunna, financed by the city council in its totality. This was the first singularity of the institution: to be born out of a municipal initiative at a time when ideas for the cultural investments and expenses of a city council (in the same way as

of County Councils, Autonomous Communities, and even the Ministry of Education), were focused exclusively on subjects related to art. A municipal budget could afford orchestras and music bands, literary competitions, dance schools, theater groups, essay, poetry or drawing contests, etc., but not something whose "odd" purpose was to communicate science to the public. It was clear that contributing to scientific culture back then, was not thought of as part of a city council's responsibility.

Inside, little over 800 squared meters were dedicated to exhibitions, and these were distributed in four stories and joined by a well-lit central stairway. There were computers, interactive modules on phenomena of the physical world, a thematic exposition that changed once a year and a floor dedicated to nature, whose contents also changed annually. Since its inauguration, a new program for the planetarium has been presented every year and the one dedicated to the Milky Way in 1993 especially stood out for its success and number of visitors. The computing section—where close to a million students from all over Galicia touched the keyboard of a computer for the first time in their lives—has been updated, and is now used for the presentation of the scientific communication CD-ROMs available in the market.

During these twenty years, more than (*** a million and a half visitors [this figure corresponds to 1985]), have gone through its halls, half out which corresponded to school visits. To this we should add another (*** half a million people) that attended one of their activities or used their services (conferences, courses, library, publications, etc.) Some of the initiatives of the House of Sciences, such as the award for Videos of Scientific Popularization have gained international prestige.

The creation of the Domus

The House of Sciences was a success of social acceptance from the very beginning, as seen by a demand for school visits which exceeded the capacity to receive them, and a waiting list of more than 200 schools. A decision was taken not to take reservations with more than a year in advance. At the same time, the population's positive reception was made manifest by the massive number of people attending all the acts which were being organized. (I remember that the week after that famous article on cold fission came out a roundtable discussion was held, and 500 people showed up to a room that could barely hold 150).

About eight years ago, it what suggested that the demand for an enlargement of the House of Sciences, with the creation of a new interactive museum, should be fulfilled. Using the same didactic criteria, a new building would be constructed to hold general and monographic exhibitions around a key topic: knowledge about "*Homo sapiens*". Human beings as individuals and as a species; the anatomy and physiology of their body; their biochemistry and how they worked; their development, origin and evolution; their interaction with the environment; their singularities and differences; human etiology, genetics, psychology; and communication, demography and anthropology would be some of the fields present in this new initiative. The Domus project had a budget of approximately 9 million euros, which once again, the Corunna's city council would have to face on its own.

Japanese architect, Arata Isozaki, was commended the construction of the building for the House of Man, which thanks to its location, would become an emblematic reference to the area corresponding to the inlet of Riazor, in the promenade of Corunna. The new facilities represent 3300 squared meters which include 1500 squared meters for exhibitions, an auditorium with an IMAX-like projection system, and the rest of the services necessary for the development of its activities.

This project is a first step in Spain towards the specialization of interactive science museums, always maintaining an interdisciplinary nature. Since the Domus is not a museum in the classical sense, neither do its contents derive from the necessity or interest to show an existing collection or series of objects. It is motivated by becoming that area of knowledge for which society shows a greater interest and demand of information for, as shown by several studies and polls, and the fact that communications media dedicate these topics a preferential attention. It follows the Greeks ancient advice: "Know thyself". In the first six months after its inauguration, Domus received 250000 visitors. Since the average time of a visit is approximately two hours, this means there was an average of 400 people at any given time.

The last event, lovingly planned, carried out and presented, has been a new center for scientific popularization, the Aquarium finisterrae, located at the feet of the Tower of Hercules, the legendary Roman lighthouse that is the symbol of the city. The marine ecosystem of the Galician coast is shown with the modern didactic orientation of the other centers, with an idea of environmental education for all the citizens, because the need to protect the marine ecosystem should be of everyone's concern. The ocean and the sea, always present in the life of Galicians, is shown as a place close to everyday life, even for those living inland, highlighting the cultural, social and traditional aspects associated to every species represented, and to the relationships between human beings and the sea.

Personal reflections

Up to now, I have given you an irregularly detailed narration of the facts. But it would not be complete without providing, from a personal viewpoint, the experience I have acquired throughout these years. The question then should be: What is the use of the House of Sciences?

Its most likely contribution has been to change the attitudes of people towards science. What citizens used to view as a distant thing, belonging to a special class of people, has become something that they can relate to in their everyday life, which is predominant in newspapers, which is related to their leisure time and the place where their children want to go to on a Sunday morning. Also, that which for students only had the absurd aspect of chemical formulas, the difficulty of physics problems or failure in mathematics exams, now shows a face connected to the modern and fun. The feeling can be summa-

rized in some comments of childhood friends of mine, who are now lawyers for example, and upon visiting the museum have said: "if this had existed when we were children, I would have studied science." Another of the objectives reached by the House of Sciences, related to the previous one, is to strengthen the feeling that science is an inseparable part of culture, affordable to all citizens. In the city, next to the offers for theatre, art exhibitions or music concerts are the ones for expositions or activities related to science, with the possible solutions for problems of ecological or technological disequilibrium.

At the same time, the experience of these years has made it common to hear about educational offers for the whole population. Not so long ago, it was accepted that only children had to be educated, and adults offered cultural proposals. Today, adults are aware that the immense majority of scientific realities that could have relevance to them and their world, did not exist during their school years, and that at the time their were not given the clues to understand or to adopt opinions on these subjects. Education is a process that lasts a lifetime.

Teachers go with their students to the House of Sciences on different approaches. Some use it as a lab, where they can experience things for which there is no material in the schools. Others want to strengthen the things they had explained in class. Many consider the visit a pleasant way to show the things they try to teach in class in a much more boring way. The truth is, almost all of them want to return. The Domus experience particularly, shows people's interest for participating in activities that lead to the own knowledge. The modules which raise the most interest in visitors are those in which they can measure their dimensions and abilities, which allow them to recognize themselves. Personal involvement is very important.

One of the few aspects that became polemic in relation to the Domus, came from architecture critics, who considered it virtually a desecration that the beautiful, almost cathedral-like space created by Arata Isozaki would be possessed by the hubbub of schoolchildren, apparently unable of admiring the quality of the building. Surely enough, the space has a value of its own. But I also know that many like to identify modern architecture with sculpture, and that some would prefer to dedicate that space to exhibiting contemporary art works or archaeological treasures. Selecting a world-renowned architect to create an interactive science museum did not only have a promotion objective inside the always complex world of the "two cultures". Although this effect was undoubtedly achieved, it also has a clear claim of cultural unity in modernity (or post-modernity), and of educational vocation for the people and for the hundreds of thousands of children that will enjoy this space noticing, without being conscious, the aesthetic keys of a new form of architecture. Arata Isozaki himself stated his satisfaction when he found out, during the presentation of his work in the Miró Foundation, the number of visitors the Domus had already received.

More general reflections

Many Spanish city councils have imitated the model of Corunna in creating science education centers. Hopefully in a not too distant future, there will be one of these centers in every Autonomous Community.

With regards to education, there is a growing conviction of the importance that the acquisition of information and the forming of opinions go hand in hand. Maybe for knowing what the hole in the ozone layer, the genome project, the air-bag, genetic engineering, the greenhouse effect, demographic explosion, human clones or the Big Bang are, the information offered by the media is enough. But a society's scientific culture depends on the adoption of scientific attitudes. It should not worry for example, that an X percentage of people ignore that the Earth rotates around the Sun, even if this discovery was made more than four centuries ago, but it is a striking fact that those who know the ideas of Copernicus, Galileo or Newton for example, continue to deal with astrology and predictions. Something has to happen in order for scientific information or data of our own culture to become relevant for each individual. I firmly believe that the population as a whole does not need to know the data for Ohm's law, or Archimedes' principle, or the valence orbitals, or complex numbers. Nonetheless, it is absolutely essential that they know and use the mechanisms for the production of science and the scientific language, that they live and enjoy the attitudes which characterize the construction of rational knowledge.

For this reason, when designing science centers, special attention is given to creating an atmosphere that stimulates curiosity—attracting attention, surprising, throwing off balance the individual paradigm that allows every one to interpret and predict the behavior of the physical world—. A critical spirit is also encouraged, suggesting diverging problems, provoking doubts, showing the provisionality of knowledge and its human nature. It is also important to demonstrate how every topic is interdisciplinary, in both the richness of its approaches and languages, as in its search for solutions. It is also possible to insinuate the need for constancy to reach the most solid convictions or to show the possibilities of creativity. All of this together with social and ethical considerations of responsibility towards future generations, which encourage sentiments of affection towards humanity and planet Earth.

It would be frivolous to take out immediate conclusions from all the expounded above for the design of a curricular model or the idea of the school of the 21st century. The big question is whether it is possible for the acquisition of knowledge needed by the young people who will dedicate themselves to scientific creation, to be compatible with the learning of other capacities with which we can say a person has the sufficient level of culture to lead a happy life, in equilibrium with their natural and technological environment.

Conclusion

Putting the detailed description of the programs, exhibitions and of activities or services in general on the side, today we can think that the creation of the House of Sciences has meant a unique contribution to Corunna in terms of thinking about education and culture at the end of the 20th century. It has proved

the citizenship's capacity to face initiatives of this scope, it is a model for interpreting the exercise of the right for education and has set out the guidelines to the integration of the scientific and humanistic cultures. In the future, they will be able to evaluate the repercussion of these works, which are from now on, heritage of the people of Corunna.