

**Nuclear Energy & Radioactive Waste: The Perception of youngsters
A Study through Educational Workshops Conducted by the Visiatome Information
Center at the CEA Marcoule (France) – 11530**

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ABSTRACT

Created in 2005, the Visiatome is an information center for the general audience, focused on the atom, radioactivity and nuclear waste. Unique in France and in Europe, this center belongs to the French Atomic Energy and Alternative Energies Commission, the public body in charge of nuclear-energy research. Visiatome comprises a 600-square meter permanent exhibition on these issues and is regarded as a repository where rich scientific information can be found.

The Visiatome welcomes around 20,000 visitors each year, of which a third are young students. Pupils from grammar, middle and high schools are welcome all year long. In addition to visiting the exhibition, this specific audience benefits from an introduction to various scientific themes – such as the atom and radioactivity – that are presented through educational workshops. This paper describes the content and operations of the Visiatome and discusses the perception of nuclear energy and radioactive waste among the young audience. This specific audience is known to be both curious and demanding, yet its everyday concerns seem very remote from the issues of energy and radiation.

The paper is based on the results of a survey conducted in September-October 2010. The survey comprised a written questionnaire given to a sample of students representing various levels in high school. In particular, the study presents a brief analysis of the semantics used by the interviewees. The results from this survey will be linked with those from a more extensive professional survey about nuclear issues conducted in the spring of 2010 among adults from the Marcoule area.

This paper also compares the results of these surveys with the experience feedback of the guides at the Visiatome who interact regularly with the young audience. This part of the paper will present the main questions asked the young visitors, and suggest appropriate answers.

INTRODUCTION

The creation of the Visiatome by the CEA (The French Atomic Energy and Alternative Energies Commission) on its Marcoule Research Center dates back to the framework of the French National Act on nuclear waste, enacted by the French parliament. In 1991, the “Bataille Act” allotted 15 years to the French public research bodies to conduct R&D focused on waste management, especially high level and long-lived radioactive waste. This Act also requested that a national public debate process be established and implemented. In 2002-2003, as the R&D period was about to expire, it became obvious that a facility was required where accurate and pedagogical information could be given to the public.

By creating the Visiatome, the CEA also expected to fulfil the recommendations of the National Evaluation Commission, an independent body working within the framework of the

“Bataille Act.” This commission urged the CEA to build a place where the progression of publically funded research on nuclear waste could be easily explained to the public.



Fig.1. The Visiatome is located in Marcoule, France.

In less than two years, and after an investment of merely 5 million Euros (partly sponsored by the European Union and the local government of the Region Languedoc Roussillon), the Visiatome project became a reality. The information center was inaugurated and welcomed its very first visitors in April 2005. Just four years later, the Visiatome reached an annual audience of 20,000 visitors, meaning it probably reached its “cruising speed.” In late 2010, the Visiatome welcomed its one-hundred-thousandth visitor – a student from a class of middle-school pupils from Avignon, the nearby “big” city. In a way, it symbolized the success of a specific part of the information offer from the Visiatome: its teaching workshops for youngsters.

CONTENT OF THE INFORMATIVE OFFER

The Visiatome was built near the Marcoule Research Center. The local environment is still very rural, and apart from nuclear science, its economy relies mostly on vineyards. The closest large urban centers are Avignon (population of 95,000; 30 minutes by car), Montpellier (population of 250,000; 75 minutes by car), and Marseille (population of 850,000; 90 minutes by car). In this geographic area called “The great Rhône River Delta,” the Visiatome is, in a way, quite geographically secluded. However, the Center is close (within a 15-minute drive) to a major motorway, which on a north/south direction, is a very important intersection for tourists travelling between Northern and Southern Europe (the Mediterranean area). Furthermore, the Visiatome is not that far from a world known tourist location, France’s Provence region, and easily reached from the airports in Montpellier and Marseille and the high-speed train (TGV) station in Avignon.

The Visiatome covers 1,500 square meters. The Center’s main content lies in the permanent exhibition that comprises a main hall dedicated to radioactivity, nuclear concerns, radioactive waste, and various types of energy. An additional hall hosts temporary exhibitions (three to four exhibitions each year) on various topics (e.g., climate change, solar energy, journey to the centre of galaxy, and from alchemy to chemistry).

Furthermore, the Visiatome promotes sharing scientific knowledge through a comprehensive yearly program of public lectures and conferences. It also hosts big events three to four times a year that are either local adaptations of some European or national initiatives (such as the French science festival or the European researcher’s night) or purely local initiatives. Usually, these events have the potential for attracting hundreds of visitors in a day.

THE PEDAGOGICAL OFFER FOR THE YOUNGSTERS: OVERVIEW

The Visiatome, which is open year-round Monday through Friday, has developed a wide array of workshops on topics such as climate change, atoms and molecules, geology, and the states of matter. Two classrooms (one chemistry/physics lab and one computer-based lab), are equipped to accommodate these learning experiences that are conducted daily for the young audience. The Visiatome encourages visits from teachers and students by adapting to the specific needs of individual classes. Basically, the professor can choose content from an “a la carte” selection of subject matter and difficulty. The regular program alternates a guided tour of the permanent exhibition, pedagogical workshops and videos on scientific topics.

In the French education system, the principles of radioactivity and nuclear energy are a part of the curriculum only in the last year of high school: the “Terminale” year during which priority is given to the objective of graduating by passing the “Baccalaureat” final exam. Moreover, these topics are relegated to courses in physics and chemistry, which are mandatory only for students choosing a major in sciences and mathematics for their Baccalaureat. That’s why we base our workshops on the assumption that most of the students coming to the Visiatome do not have any general or accurate knowledge about energy in general and nuclear energy and related topics in particular.

In partnership with the French Minister of National Education (which provides the help of a scientific professor half a day each week, to ensure that the content of the workshops aligns with those of the schools), the Visiatome trains pupils from grammar school to high school. The topics presented are numerous: history of science and technologies, energy strategies, environment, discovery of the researcher’s universe, plastic arts, information and communication technologies, electricity, various types of energy, nuclear physics, states of matter, chemistry, and sustainable development. Obviously, the diversity of these topics enhances the schools’ curricula, thus explaining the interest and the credibility given to the Visiatome by the professors. When they take their classes to the Information Center, they feel that they are visiting a place dedicated to sharing scientific information “in general” rather than one completely focused on nuclear “propaganda.” This probably helped a lot in establishing the credibility of the content.

The guided tour of the permanent exhibition lasts from 45 minutes to 90 minutes, depending on the level of the group. The visit is limited to small subgroups of 15 pupils and is managed by a “scientific mediator” who provides general comments and answers questions. The visit can be either very general, allowing an overview of the topics presented at the Visiatome, or focused on a particular subject set ahead of time with the professor. Interactive booths or kiosks are scattered throughout the exhibits, as are short quizzes – all intended to stimulate the minds of the visitors and allow them a much more self-based experience.



Fig. 2. Interactive software helps “personalize” visitors experience at Visiatome.

Visiatome’s strategy in addressing the topic of nuclear waste is to educate the visitors through a very classical path that starts with “conventional waste” and ends with nuclear waste. The messages are simple: our modern societies produce lots of waste. In France, for example, each citizen produces 500 kilograms of household waste each year. Further, modern convention is to “sort” waste into recyclables, paper, and garbage – practices the average person and household are familiar with. That’s why the exhibition starts with concepts that are broadly accepted and shared among the youngsters. Indeed, the younger generations generally are more culturally open to concepts such as selective sorting and sustainable development. This basic understanding and acceptance is essential to explain topics that are significantly more complex, and in some cases extremely controversial (.e.g., atoms, radioactivity, nuclear energy). After the discussion of “conventional waste”, the main exhibition leads the youngsters through booths, posters, and video games presenting the basics of radioactivity, before giving them an in-depth look into how nuclear waste is generated, categorized, handled, and stored. A specific part of the exhibition is dedicated to the research conducted on nuclear waste in the framework of the national 1991 and 2006 acts. Concepts such as partitioning, transmutations, geological storage, long-term behaviour, ethics and responsibility are then provided to the classes.

Typically, the teaching workshops last from 60 to 90 minutes. Each of the two classrooms can hold up to 15 pupils. The small size of these groups is, in a way, a guarantee of quality: the general feedback shows that professors do appreciate these intimate groups of students. They consider that the pupils are individually encouraged to interact with the scientific mediator managing the group. During a workshop, the youngsters not only are presented basic scientific concepts, but also encouraged to propose explanations for the phenomena and then see scientific experiments demonstrating the concepts. Alternatively to the presence of a scientific mediator, some of the workshops are directly presented by the researchers themselves. It is essential to note that the pedagogical workshops were designed by the researchers, and not by the scientific mediators. All the information required to conduct the workshops are widely shared among the small team of six young scientific mediators who are technical communication specialists. In a way, the Visiatome approach to teaching workshops can be considered close to the “hands on” method in the U.S. (or its French equivalent: “la main à la pâte”).



Fig. 3. Teaching workshops at the Visiatome engage the students.

As shown in the table below the subject matter in the workshops is geared to students in three identified levels of education: grammar, middle and high school.

Table I. The 10 basic workshops are available to students based on their grade level.

WORKSHOP TITLE / LEVEL	GRAMMAR SCHOOL	MIDDLE SCHOOL	HIGH SCHOOL
States of matter	■		
Drinking Water	■		
Bioluminescence	■	■	
Energy	■	■	■
Climate	■	■	
Partitioning of hidden elements	■		
Radioactivity		■	■
Let's discover glass !		■	■
Molecules		■	
Geology		■	

PERCEPTION BY THE YOUNGSTERS: A SURVEY STUDY

Since the Visiatome opened in 2005, students consistently represent a third of all the Center's visitors. This audience is strategic when considering that today's students will be tomorrow's citizens. A general, yet quite informal, feedback from the operating team at the Visiatome indicated a good satisfaction among both the professors and the young visitors. However, to get more definitive feedback, a short survey was specifically developed and implemented in the autumn of 2010 to learn about the students' interest in and satisfaction relative to the topics presented and evaluates their "perceptions" based on the language/semantics they used in their answers. More than 300 pupils from local high schools were surveyed, and a sample

of 100 was picked randomly. The survey queried the students before and after they visited the Information Center. Before they entered the facility, they were asked to answer to five questions focused on their knowledge and individual feeling about the topics they were about to discover. They were asked to answer a sixth question after they had visited the permanent exhibition and attended the “radioactivity” workshop. The questions and data for the responses are provided below. The first question was “Before coming to the Visiatome, have you already heard about the atom, radioactivity, and nuclear waste?” The answers show that a huge majority (86%) indicated that they believe they already knew about or were familiar with these topics. Only a very small part of the sample answered negatively.

The second question was “Are you interested by these topics: the atom, radioactivity, nuclear energy, nuclear waste?” Approximately 65% of the students said they were interested in these topics, with about 53% answering “Yes, I’m interested a little bit in these topics,” and 12%, answering, “Yes, I’m interested a lot in these topics” A quarter of the answers showed little or no interest, with 19% of the respondents answering “No, I’m not really interested in these topics.”

The third question was “Among these topics: the atom, radioactivity, nuclear energy, and nuclear waste, please score (from 0 to 3 points) the ones you feel more or less interested in.” The answers were recorded as follow: radioactivity is the most interesting topic with 164 points, followed by nuclear energy with 154 points, the atom with 130 points, and nuclear waste, which got the least interest, at only 101 points.

The fourth question was a semantic-oriented one, asking young visitors to write down “the words, the expressions, and the ideas that spontaneously come to mind when they think about the topics.” It is noteworthy that 20 % of the answers were left blank (fully or 50% of the possible answers blank), suggesting that a many of the youngsters, when asked about ideas about the topics... simply don’t have any ideas at all (despite the fact that they pretend to be interested by these topics). “The atom” topic generated words and expressions related to a quite “neutral” physical description: bowl, nucleus, electrons, small, protons, neutrons, nanotechnologies, molecules. “The radioactivity” topic largely suggested words and expressions related to a global negative perception, with answers such as: disease, illness, Chernobyl, danger... “The nuclear energy” question suggested much more scattered answers, with semantic contents linked to energy production, electricity, plants – even with some reference to the famous Simpsons cartoon (!) - Electricity corporations, but also with still a significant part of the answers being the words: nuclear bomb, explosions, pollution. “The nuclear waste” question suggested words such as: danger, pollution, toxicity, bury (them), dead-end/no way, population, nature.

The fifth question asked pupils “Do you think that these topics are easy or difficult to be presented or to be understood?” Here, if a third of the answers remained blank, showing a rather indifference, 50% of the answers pointed out that these issues are “difficult to be presented, or difficult to be understood.” Explanations spontaneously given were: it is too complex, it is too wide a field, or it needs a basic knowledge and education to be understood. Only 7% of the pupils felt that these topics are easy to be presented and understood.

The sixth and last question, asked after the students had visited the Center and attended a workshop on radioactivity, focused on their “interest” and the feeling of “having learned something.” Two thirds of the answers indicated that they were interested in the workshop, while nearly three quarters said they felt they learned something. Then, a final part of the question asked about their interest in the permanent exhibition. The overall perception was positive: 46 % found the exhibition interesting and 23% found it very interesting.

The results of this limited survey were not surprising but confirmed that the content and the methodology used at the Visiatome are efficient. For sure, the topics presented at the Visiatome are considered quite far from the everyday priorities and centers of interest of these young visitors. Yet, did the general feeling about the topics point to rejection or defiance? It's hard to say considering the limited distribution of this survey... But what it obviously showed was a lack of knowledge. The youngsters showed interest in the topics but in fact they just didn't have a grasp of the content. Our analysis is that the youngsters consider the topics as different parts of a puzzle that they are unable to connect. Considering the semantic part of the survey, the words used by the interviewees tended to show that they consider nuclear and radioactivity as a source of energy (to sum up : plants producing electricity...) but with no precise idea of how it is done and through which processes and with which advantages. The fact that some very negative words and expressions (bombs, Chernobyl, explosion) were frequently found among the interviewees may be considered proof of the existence of a "common sense" definition of the nuclear fields, widely and early spread over the population.

These results may be linked to a survey conducted during the spring 2010 by a specialized survey institute among a sample of 400 adults living in the communities around Marcoule. This survey, ordered by the CEA to assess the recognition and the impact of Marcoule Nuclear Research Center, notably pointed out the fact that the impact of the research center is considered positively when talking about economic impact, job creation, trade, and local equipments but is considered negatively when talking about environment and health of local inhabitants.

This is probably a very classical view and point out what still lies as one of the major difficulties in talking about radioactivity and nuclear-related topics: facts versus perception. The facts – and especially the ones that may be considered as positive and benefits for a local or a national community (access to a readily available source of energy, a very limited production of waste in terms of volume and toxicity, a limited or insignificant impact on environment and health) – are often overshadowed by the negative perceptions widely shared among people since their childhood.

How can we consider the ability of the Visiatome to fill that gap? Since the students are a captive audience, we must use figures and present conclusions with care. After all, these pupils do not come to the Visiatome on their own decision but as the choice of their professors to let them explore a new field of knowledge. But as the autumn survey indicated, a narrow path does exist. Two thirds of the answers showed that the topic of the workshop – radioactivity – interested them. And almost three quarters of the answers showed that the pupils left the workshop with a feeling of having learned something. These results did not surprise the scientific mediators in charge of the visits and of the workshops. These professionals generally consider that the youngsters are a difficult and demanding audience, but that with an interactive and an experiential approach especially during the workshops – it is always possible for the youngsters to put together the "pieces of the puzzle"...and this is already quite a good beginning on the path to knowledge.