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A Corporate Social Responsibility Project to Improve the Democratization of Scientific Education in Brazil

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***Abstract*—**Nuclear technology is part of our everyday life and its beneficial applications help to improve the quality of our lives. Nevertheless, in Brazil, most often the media and social networks tend to associate radiation to nuclear weapons and major accidents, and there is still great misunderstanding about the peaceful applications of nuclear science. The Educational Portal Radioatividades (Radioactivities) is a corporate social responsibility initiative that takes advantage of the growing impact of Internet to offer high quality scientific information for teachers and students throughout Brazil. This web-based initiative focusses on the positive applications of nuclear technology, presenting the several contributions of ionizing radiation in different contexts, such as nuclear medicine, agriculture techniques, food safety and electric power generation, proving nuclear technology as part of modern life and a must to improve the quality of our lifestyle. This educational project aims to contribute for democratization of scientific education and social inclusion, approaching society to scientific knowledge, promoting critical thinking and inspiring further reflections. The website offers a wide variety of ludic activities such as curiosities, interactive exercises and short courses. Moreover, teachers are offered free web-based material with full instructions to be developed in class. Since year 2013, the project has been developed and improved according to a comprehensive study about the realistic scenario of ICTs infrastructure in Brazilian schools and in full compliance with the best e-learning national and international recommendations.

***Keywords*—**Information and communication technologies, nuclear technology, science communication, society and education.

I. Introduction

THE pacific applications of nuclear technology contribute to improve the quality of our lifestyle in more contexts than people realize. Nevertheless, the best known examples among the general public seem to be the nuclear weapons and major nuclear disasters, such as Chernobyl and Fukushima. In Brazil, there is still great misinformation about the beneficial uses of radiation and safety concerns divide public opinion.

According to some surveys conducted by GlobeScan in 2005 [1] and Eurobarometers in 2010 [2], the higher the education level, the more favorable are opinions towards nuclear power. The GlobeScan survey [1] for the International Atomic Energy Agency (IAEA) covered 18 countries, with 1,000 respondents in each one of the participant countries. According to this survey:

> *"Overall, men (33%) and people with high levels of education (36%) are more inclined than women (23%) and those with low levels of education (24%) to say that nuclear power is safe and that interested countries should build new nuclear power plants. People with less education (28%) are more likely than the well educated (21%) to say that nuclear power is dangerous and that all plants should be closed down."* [1]

Eurobarometers, used to measure public opinion in Europe and overseas, conducted a survey entitled "Public Attitudes to Nuclear Power". The survey´s results were published by the Nuclear Energy Agency (NEA) and the Organization for Economic Co-operation and Development (OECD). According to the reported conclusions, "*respondents with higher levels of education are more likely to think that the advantages of nuclear outweigh the risks*" [2].

However, a new survey conducted by GlobeScan for BBC World Service brought different trends. This survey was published in 2011 and covered 23,231 citizens across 23 countries. According to this last survey, opposition to nuclear energy had increased in many countries after Fukushima crisis [3]. The results suggest that public's reluctance to accept nuclear energy has increased in five among eight countries that were also polled by GlobeScan in 2005. The most negative impact was in Germany, where 52% of the population supported the government's new policy of shutting all the nuclear energy facilities [3].

In Latin America, opposition is well-marked among the countries that do not operate nuclear plants. In Chile, 55% of respondents think that nuclear energy is dangerous and should not be used. In Ecuador, 53% of respondents were against nuclear power generation. In Panama and Peru, respectively, 38% and 30% of the respondents think nuclear power generation should be abandoned and that active plants should be immediately shut down. Brazil was one of the participating countries.

> "*In Brazil – which operates a few nuclear plants and was surveyed for the first time in 2011 – a plurality of 44 per cent of Brazilians says that their country should continue to use the nuclear power stations that are already in operation, but not build new ones. Thirty-five per cent say that nuclear power is dangerous and that all operating nuclear plants should be closed down as soon as possible – above the 12-country average (30%) – and only 16 per cent support the building of new nuclear plants – below the 12-country average (22%).*" [3]

Most likely the negative public perception of nuclear power would be different if the national authorities and scientists took more time to invest in nuclear science communication.

Science communication is crucial to increase public understanding of nuclear technology's peaceful applications.

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Whenever government itself lacks the resources to accomplish some missions towards society, private companies may offer great advantages through corporate social responsibility projects. Corporate social responsibility is one of the standard business practices nowadays. Balancing profits and social responsibility, private companies achieve a positive impact on society, contributing to sustainable development, by investing in social or educational programs. Therefore, taking advantage of the growing impact of Internet, this corporate social responsibility invests on the potential of new web-based technologies to offer high quality scientific information about the peaceful uses of nuclear technology and its benefits. This project takes into account two main issues: (i) public opinion is based on experience of the population with the available information about risks and benefits, and (ii) it is not a coincidence that more informed people favor nuclear technology [4]. This educational initiative aims the democratization of scientific education, approaching society to scientific knowledge and promoting social inclusion, informing children and teenagers, as well as their parents and teachers, who are most often unaware of the matter. Since this project aims for the popularization of science, all courses are offered to the public at absolutely no cost. Education transforms old prejudices and inspires new thoughts, stimulating development and encouraging scientific and technological research [4].

II. ICTs Possibilities in Brazilian Schools

The web-based educational project [5] entitled RadioAtividades (RadioActivities) aims the communication and education of nuclear technology contents for teachers and students of the Elementary and High Education in Brazil. Therefore, there was conducted a comprehensive study regarding the impacts, possibilities and challenges of the Information and Communication Technologies (ICTs) throughout the country. This study enabled the collection of qualitative and quantitative reference data about the academic public profile. These data were essential to define the best interfaces, tools and resources for the Educational Portal Radioatividades. According to the survey ICT Education 2011 [6], Internet access has increased all over Brazil. The survey comprehended interviews with 1,822 teachers, 606 directors of studies, 640 principals and 6,364 students between October and December, 2011. This survey brings the ICT situation and ICT trends in year 2011.

> *"The relationship between the frequency of activities carried out in pedagogical practices and the use of ICT suggests a challenge to incorporating technologies in education. There are signs that an increasing number of activities carried out in classrooms will create opportunities for the introduction of ICT in the teacher-student relationship. This is because ICT are used more often to carry out the least frequent activities proposed by teachers. Although there are limitations to the ICT infrastructure of Brazilian schools, the relationship between the most frequent activities and the use of these tools may be indicative that teachers are still struggling to change their teaching practices traditionally carried out without computers or the Internet. Students in turn, incorporate more naturally the use of computers and the Internet in their school activities. The indicator on activities using ICT shows that 82% of the students do school research using computers and the Internet. Furthermore, 74% of them prepare theme projects using ICT, and more than half claim to use these tools for homework assignments (60%)."* [6]

Moreover, this publication reports students´ use of Internet all over the country. According to this survey, 40% of the interviewed students were up to 13 years old, and 20% from 14 to 15 year-old students. Regarding the access in Brazil´s different regions, 34% of the surveyed students in Northeast and 33% in Southeast regions declared to use Internet, while in South region this percentage was only 16%. The Center-West and North regions had the lowest average rate and together represented 17% of students' access in Brazil. Research activities appeared in first place among the predominantly activities involving the use of the Internet for school assignments. Also, 82% of the total number of students in public schools declared to use a computer or the Internet. This percentage was even higher (96%) among teachers and students in private schools: "*as well as in public teaching institutions, students in private system also use ICT in their school assignments, particularly for school research"*.

Furthermore, this survey shows a comprehensive picture of ICT infrastructure in public and private schools in year 2011, considering the number of students per school and the number of computers in working condition. In public school facilities, there were approximately 500 students per school and 20 operational computers. Even though 93% of Brazilian public schools declared to have access to Internet, 32% of these institutions had connection speeds between 1 and 2 Mbps and about 25% of the facilities had even lower speeds. Wireless connections were available in only 45% of the institutions. Private schools, offered a higher quality of computers and Internet, which increased the use of ICTs among students. Private institutions counted a ratio of 29 working computers, nine more than in public institutions. Also, private facilities had fewer classes per grade and fewer students per class [6]. These data allowed the experts to start the system intelligence and the development of educational models for nuclear technology content. In July 2014, the pilot project was implemented in a web environment, using the Web 2.0 tools and resources that allow the entire organizational structure [4]. There was developed a platform whose range of features and functionality suits the needs of the academic public. The expert team of the Educational Portal Radioatividades studies, since then, all annual official publications about the use of ICT in Brazilian schools, with a closer look at public schools, with fewer ICT resources.

In 2014, there was published the most recent survey regarding ICT use among students and teachers in schools throughout Brazil, as presented in Table I. It is most recent publication of this entity up to this date [7].

TABLE I
ALLOCATED SAMPLE SIZES BY REGION

Region	Number of schools
Center-West	325
North	290
Northeast	280
Southeast	333
South	258
Total	1,486

Source: ICT in education survey 2014 [7]

According to the 2014 edition, 98% of public schools have at least one computer, 92% of these have Internet connection. However, 41% of public schools with Internet connection have connection speeds of up to 2 Mbps, which means that low connection speeds remain the most prevalent. Public school principals mentioned the major factors that hinder the pedagogical use of ICT: obsolete equipment and lack of maintenance [7].

Desktops are still the most common device, present in 99% of public schools, 2014 edition points the growth trend for the presence of mobile devices, with an increase of 30 percentage points over the last five years in Brazilian public schools. Among private school students, the trend toward the use of mobile devices is even more pronounced than among public school students.

A. Use of Technologies by Public School Teachers

In 2014, there were interviewed a total of 1,700 teachers. The results show that 97% of them used Internet resources to search for content to be used in the classroom [7].

There has also been an increase in the number of teachers who searched for sample lessons plans online, a percentage that went from 68% in 2012 to 80% in 2014. Nevertheless, the use of ICT in the public school environment presents some problems, due to low connection speeds. ICT in Education Survey 2014 emphasizes that "*the pedagogical use of information and communication technology resources requires the simultaneous connection of several devices to the same connection network*." Therefore, the use of isolated contents, such as images and videos, is more common than the use of complete materials, such as video lectures or readymade presentations [7].

The teachers interviewed considered themselves skilled in using ICT digital resources in their teaching practices. A greater percentage of the teachers who were surveyed seek contents that involve more interactive participation of students, such as educational software (47%). The results also indicate that 86% of the teachers altered some of the resources obtained online to prepare classes [7].

Table II brings the proportion of teachers according to the type of resource obtained on the Internet for preparing classes and activities for their students.

Data on teacher profiles and the way they use ICTs in the school environment reveals the gradually increasing application of technological resources in their teaching practices.

TABLE II
PROPORTION OF TEACHERS BY TYPE OF RESOURCE OBTAINED ON THE INTERNET FOR PREPARING CLASSES OR ACTIVITIES

Resource obtained on the Internet	Percentage of total number of public school teachers
Images, figures, illustrations, or photos	82
Varied texts	80
Videos, films, or animations	77
Video-classes	71
Lists with reading suggestions	62
Ready-made presentations	47
Computer/software educational programs	47
Games	44
Podcasts	21
Other	6

Source: ICT in education survey 2014 [7]

B. Use of Technologies by Public School Students

The most recent publication of ICT in Education Survey up to this date [7], also confirms that the national results for Internet access by students via mobile phones was 62%, higher in regions North and Northeast. The 2014 edition of the survey continues registering the increase in Internet use via mobile phones. In 2013, 59% of these students used mobile phones to access the Internet and in 2014, this percentage increased to 79%. The survey brings and emphasizes the UNESCO (United Nations Educational, Scientific and Cultural Organization) recommendations, as written below:

> *"Most public policies aimed to introduce ICT in the school environment, as indicated by the UNESCO document "Policy guidelines for mobile learning," were created before the advent of mobile devices and few mention these resources and an even lower number foresee the full use of their potential (UNESCO, 2014). The same document highlights the need for reviewing these policies to include mobile technology, a pressing need when considering the trend observed regarding the growing presence of this technology in schools. In this context of increased presence of mobile technology in schools, measures that fully restrict the use of these devices, or that completely limit student access to the Wi-Fi network, as occurs in 96% of public schools with wireless connection, are not recommended by UNESCO's policy guidelines for mobile learning."*

As a matter of fact, 73% to 75% of the surveyed students declared to carry out schoolwork through the use of ICT at home for specific projects or assignments, homework, exercises, and research at home ranges [7]. Table III, developed according to the results of ICT in Education Survey 2014, demonstrates the proportion of students by computer and Internet use in activities. Among those whose households have computers, 76% have portable computers and 61% have desktop computers. The tablet was present in 43% of student households, a result of significant growth (28 percentage points) since 2012 when the survey began measuring the presence of this equipment in the household. The ICT Households survey, carried out every year by Cetic.br since 2005, demonstrates this trend in recent years: in Brazilian households located in urban and rural areas, the portable

computer has already surpassed the presence of desktop computers (60% versus 56%), and there is also a greater presence of tablets, which reached 33% of households in 2014. Furthermore, for the first time, the tablet appears as the only type of computer present in 6% of Brazilian households [8].

TABLE III
PROPORTION OF STUDENTS BY COMPUTER AND INTERNET USE IN ACTIVITIES, BY GRADE (2014)

ICT in activities carried out by students	Percentage of total number of public school students	
	(1)	(2)
School research	83	94
Group assignments	55	87
Theme projects or assignments	66	83
Doing homework and exercises	57	76
Presentations to classmates	30	62
Playing educational games	81	42
Talking to the teacher	20	21
Taking part in e-learning courses	04	10

(1) 5th year of elementary education
(2) 9th year (elementary school) & 2nd year (secondary education)
Source: ICT in education survey 2014 [7]

III. WEB-BASED SYSTEM DEVELOPMENT

The aim is to develop a platform whose range of features and functionality suits the needs of the Brazilian academic public, the challenge involved the ability to create an effective, but at the same time flexible system that allows quick integration of new trends in web technology [4].

Regarding the development and infrastructure issues, there was used a combination of multiple technologies, maximizing the resources available in each one in order to achieve the project´s goals. This is an original project with the prospect of long-term use. For this reason, it was considered the HTML (XHTML1 STRICT) patterns, according to the W3C (World Wide Web Consortium) recommendations. Considering an infrastructure that supports an average volume of service access, the Linux operating system and MySQL server database were chosen. Whether during the implementation phase or hereafter, the server has to be rescaled to increased demand, the team can easily migrate the database to a server MSQL Server. PHP web development was chosen due to its versatility. Not only it is an open-source free of costs, but also it enables to support major web servers and databases. PHP offers a vast range of resources and components developed and updated by a large community who regular updates tutorials and a complete online documentation. Also, the project is developed in full compliance with Web 2.0 best practices, making use of CSS (Cascading Style Sheets) and can be adapted to multiple devices such as desktops, tablets and cell phones (responsive content). This technology also allows the development of components for information sharing and interfacing with external systems. Moreover, there was taken into account a great concern with SEO (Search Engine Optimization) recommendations, ensuring that the information is well indexed by search engines in Internet. [4].

IV. NUCLEAR SCIENCE CONTENT FOR CHILDREN AND ADULTS

The website RadioAtividades (RadioActivities) counts on an original and modern design, with several thematic roles to engage children and teenagers, as seen in Fig. 1. When entering the website, visitors are informed about the teaching philosophy adopted by this web-based educational initiative: We do not study the history of navigation from shipwrecks, we do not learn the history of aviation from the air accidents, and we do not have to learn nuclear science from bombs and accidents. Nuclear technology contributes to an increase our lifestyle and brings great contributions to medicine, industry, agriculture, electric energy and art [5].

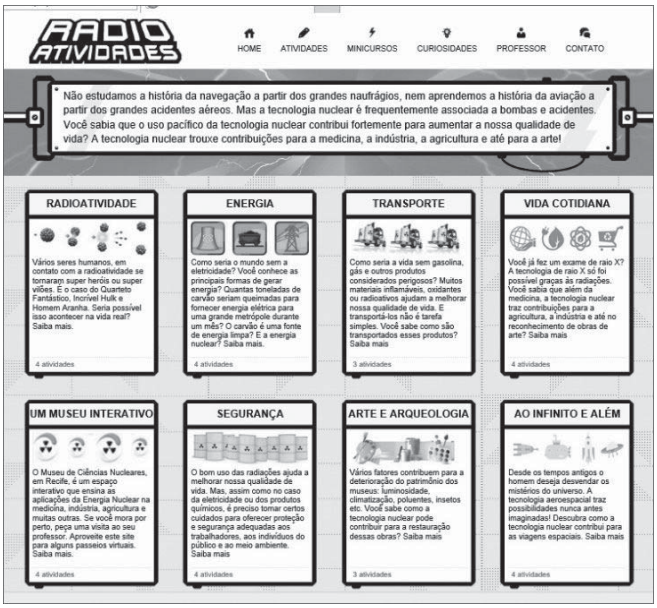

Fig. 1 Educational Portal Radioatividades: A creative design to please children and adolescents [7]

The website counts on modern Internet resources, according to the best educational practices, enabling children and adults to see and review the content with great qualitative, and also great quantitative achievements. The web design is composed by colorful cards with different themes to please and hold the young audience´s attention. This educational portal provides a range of ludic activities such as curiosities, interactive exercises and short courses, covering topics related to nuclear technology and its beneficial applications in several areas, such as nuclear medicine, agriculture techniques, industrial applications, food irradiation, radiological protection and electric power generation, among others.

Students are offered a high quality content including concepts and theory, as well as a vast range of interactive exercises, which invite children and teenagers to learn and explore the puzzles of nuclear science. Fig. 2 brings an example of a “drag and drop” activity to compare the heat value of uranium with other energy sources, such as fossil fuels or natural gas [5].

Fig. 2 Educational Portal Radioatividades: interactive activity [7]

The website presents different themes that comprise the various aspects of the beneficial applications of radiations, as described below:

- Radioactivity - Based on the story of famous superheroes or super villains, such as the Incredible Hulk, Spiderman and the Fantastic Four. This subject presents the radioactivity, and its biological effects on human health, among other curiosities related to the subject.
- Nuclear power generation - The topic discusses the renewable and non-renewable energy, as well as challenges and possibilities of electric energy generation, emphasizing the benefits of nuclear energy and explaining the fuel cycle.
- Safe transport of dangerous goods - This theme discusses the transport of dangerous goods, which are essential to provide a high quality lifestyle, such as alcohol, gasoline, varnishes and also radioactive materials. Interactive activities and online courses teach international pictograms used in the transportation of these products and present the specific pictograms and UN recommendations on the transport of Class 7 material.
- Everyday life - The topic discusses the several contributions of nuclear energy to improve the quality of modern life in more ways than people usually realize. The content includes the safe use of radiations in several fields, such as medicine, agriculture and industry. Moreover, there are presented some contributions to the population´s safety, such as smoke detectors and the x-ray machines in airports, museums and stadiums.
- Art and archaeology – This item offers a wide perspective on how radiations help us to preserve and understand the world´s cultural heritage. Two of the short courses present the contributions of nuclear technology in the restoration, maintenance and recognition of works of art in museum collections.
- To infinity… and beyond! – Rockets and submarines have always stimulated young minds' imagination. This topic discusses the new nuclear submarines, as well as the contributions of nuclear technology to space missions, such as the use of plutonium-238 as a power source on NASA´s Curiosity rover.
- Healthy food – this topic teaches the contributions of ionizing radiation to the global supply chain through the reduction of potential pathogens. The topic discusses food safety and human diseases, food loss and waste, shelf-life extension of perishable food and economic impacts, which includes foreign policy implications and food export restrictions.
- Travelling around the world – The topic offers an overview of radiations around the world through different perspectives, such as electric power generation, nuclear medicine and natural radiation, among others.
- Security and protection – This item offers basic content on radiation protection and safety concerns, presenting most common actions to protect the general public, the workers and the environment. Moreover, this topic teaches specific concepts, unities and measurements related to radiation protection.

For each theme, there were developed different strategies for getting students´ attention.

For a young audience, who most commonly has a passion for space missions, the theme “To infinity… and beyond!” brings information about nuclear science contributions for space exploration and space travel. Curiosities entitled “We finally found water on mars!” and “Pluto, our dearest ex-planet” were designed to capture children´s attention.

“Art and archaeology” invites the public to discover some unmissable treasures in London's museums, such as the famous Natural History Museum and the British Museum. Also, the website presents the nuclear contributions related to most impressive and interesting landmarks, such as the ancient Machu Picchu Inca ruins in Peru and the great pyramids of Giza in Egypt.

“Security and protection” is an essential theme, for there are still many myths and unfounded misunderstandings about the risks involving the harmful effects of ionizing radiations. People fear what they cannot understand. Therefore, the theme brings together several pieces of information about the safe use of ionizing radiation, introduces measures and units related to radioactivity and exposure, and discusses the principles of radiation protection. Liking the theme to everyday life, the website brings information about the radiological security operations in FIFA World Cup in Brazil, as seen in Fig. 3.

Regarding the national [6], [7] and international [9] recommendations for mobile devices, from November 2015 all website content was equally available in app for android mobile devices [10].

Moreover, taking into account that nuclear science is not usually introduced into the school curriculum, and that teachers are commonly unaware of the matter, this educational project provides pedagogical support, offering supplementary teaching material and further references to be developed in class. The content bank is designed to enhance teachers´ understanding about nuclear sciences, providing different materials for free download, such as Power Point presentations, games, journal news and ludic activities. One of

the most interesting ways to understand nuclear energy is the possibility to relate it to life on Earth. Other than the common sense about nuclear weapons or atomic war, the website presents radiations as a natural occurrence revealing that life on Planet Earth is only possible because of radiations. For this reason, teachers are given themes such as: "How does life on Earth depend on nuclear energy?" and "Stars: they are the factories of all the things we see on Earth". These themes allow teachers to explain the difference between atomic and chemical interactions, nuclear fission and nuclear fusion, the formation of the periodic table elements and the concept of radioactive atoms. Another example is the Brazilian Multi Proposal Reactor, which has caused reluctance of environmentalists and of the local population. Nevertheless, this research reactor, still under construction, will be very important to produce radioisotopes for medical applications. To bring a new perspective of the Multi Proposal Reactor, the content bank offers information about Nuclear Research Reactors and explains the production of radiopharmaceuticals, discussing the importance of nuclear medicine for the diagnosis and therapy of various diseases [4]. Furthermore, the website counts on a restricted access area for teachers, which enables our team to collect relevant reference data about teachers´ profile, such as: who are they? Which subjects do they teach? How old are their students? What kind of material are they interested in? These and other questions will enable a new perception of teachers' habits suggesting new possibilities for the development of the system.

V. Discussion and Results

The system structure was designed and constructed taking into account the appropriate balance between flexibility and robustness, allowing to adjust the system to the fast changing world of ICTs possibilities. As a long-term project, the two major concerns are to understand the audience's habits and to analyze technological trends as time goes by, continuously checking the availability of emerging technologies and new tools. Up to this moment, the project counts on two integrated modules: the website and a Learning Management System (LMS).

Google Analytics is used to the investigation of the website usage profile. It reports information about users´ operational systems profiles, services providers and screen resolutions, collecting fundamental information for strategical planning of the evolution of this Project, as the WEB platform tools and functionalities must be developed according to our target public needs, regarding new possibilities of media, mobile access, feeds of content and information sharing. Nevertheless, Google Analytics provides only the profile information related to the website content. Analytics is not able to track the audience overview in an external LMS environment and online short courses and interactive activities run in an external eLearning system. Moreover, the target audience is made up of children and adolescents who commonly are not allowed to fill in forms with personal data, there are no inscriptions asked to enter the system. Due to the fact that traditional LMS platforms do not allow to analyze the audience overview without visitors´ inscriptions, in June 2015 a customized LMS was created with a tracking system to follow computers IPs. Therefore, even without visitors´ inscriptions, the tool provides our team detailed data, such as how many courses or activities each user accesses and concludes.

Fig. 3 Educational Portal Radioatividades: nuclear and radiological security for the FIFA World Cup in Brazil [7]

Fig. 4 Educational Portal Radioatividades: app for mobile devices [7]

TABLE IV
Google Analytics Reports: Browsers

	01/07/14 to 30/06/15	01/07/15 to 30/06/16
Chrome	66.93%	68.08%
Internet Explorer	16.34%	12.82%
Android	4.05%	3.02%
Safari	4.58%	4.35%
Firefox	5.75%	7.62%
Mozilla	0.26%	----

In August 2015 it was already possible to track these two independent monitoring systems crossing information, which brought a new perception of users' habits, enabling important data to suggest new possibilities for the development of the system.

VI. Conclusion

In Brazil there is still great misinformation about nuclear science and the beneficial uses of ionizing radiation. Public opinion is strongly affected by the media and social networks, which commonly associate radiation to nuclear weapons or major accidents. The most negative repercussion among the general public seem to be the harmful radiation effects from nuclear power plants accidents, such as Chernobyl and Fukushima. Overall, people seem to be fearful about risks and possible side effects of activities involving ionizing radiation. Science communication is a must and the public opinion would be different if the authorities and the scientific community took more time to invest in the education of the population, informing the general public.

According to some international surveys, more informed people tend to favor nuclear technology. This corporative social responsibility project takes into account that education is the foundation of every society and that Internet growing access can facilitate learning providing large-scale instruction. The educational portal was designed to offer high quality scientific information, presenting the beneficial uses of nuclear science linked to our everyday life. The website introduces nuclear technology in different contexts, such as agriculture, industry, medicine, electric power generation, and aerospace applications. The target public is constituted by the academic public in several levels, including children, teenagers and their teachers, who are also, most often, unaware of the matter.

The system was created and developed according to a comprehensive study about the realistic scenario of ICT infrastructure in Brazilian schools. Nevertheless, despite ICTs potential to increase education, there are still great challenges to the effective use of computers and the Internet: numerous public schools in Brazil still count on slow Internet connection and obsolete equipment. In order to improve teaching practices and increase ICT use, teachers are given pedagogical support, which includes a database with free download presentations, references material and ludic games with full instructions to develop in class.

Educational Portal Radioatividades is a corporate social responsibility project for science communication, approaching society to scientific knowledge. Only education has the power to transform unfounded prejudices and inspire critical thinking, encouraging development and stimulating scientific and technological research.

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