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Comprehensive Analysis of Guided Tours to the RA-6 Nuclear Research Reactor: Educational, Research, and Social Perspectives

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Abstract: Guided tours of the RA-6 nuclear research reactor provide a unique opportunity to bring students, teachers, researchers, and the general public closer to the reality of this technology. They aim to promote a deeper understanding of its operation, facilities, applications, and safety protocols, with the goal of dispelling misconceptions, overcoming myths, and alleviating associated fears. Year after year, from 2018, excluding the pandemic period, the number of visitors has increased, reaching over 3000 individuals in 2023 from Argentina and various regions of Latin America and the world. This increase has had a positive impact on both the community and public perception regarding nuclear technology.

Keywords: research reactor, outreach, public perception, education.

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Análisis integral de visitas guiadas al reactor de investigación nuclear RA-6: perspectivas educativas, de investigación y sociales

Resumen: Las visitas guiadas al reactor nuclear de investigación RA-6 ofrecen una oportunidad singular para acercar a estudiantes, docentes, investigadores y público en general a la realidad de esta tecnología. Además, buscan promover un entendimiento más profundo sobre su funcionamiento, instalaciones, aplicaciones y protocolos de seguridad, con el objetivo de desmitificar creencias erróneas, superar mitos y disipar miedos asociados. Año tras año desde el 2018, exceptuando la época de pandemia, la cantidad de visitantes ha experimentado un aumento, llegando en 2023 a más de 3000 personas, provenientes de Argentina y diversas regiones de Latinoamérica y el resto del mundo. Este incremento ha tenido un impacto positivo tanto en la comunidad como en la percepción pública con respecto a la tecnología nuclear.

Palabras-clave: reactor de investigación, divulgación, percepción pública, educación.

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1. INTRODUCTION

1.1. The RA-6 research reactor

The RA-6 research reactor, operated by the National Atomic Energy Commission (CNEA), is located at the Bariloche Atomic Center. This reactor was conceived and constructed for education, training, and nuclear research, closely linked to the Balseiro Institute (IB). Recognized as the School Reactor, it stands out for its academic activities and research lines in Boron Neutron Capture Therapy (BNCT), neutron radiography, neutron tomography, Neutron Activation Analysis (NAA), Prompt Gamma Activation Analysis (PGAA), and pulsed beam techniques. Currently undergoing installation are a neutron diffraction facility and a cold neutron source, expanding its research capabilities. [1].

The RA-6 collaborates mainly with the IB and also with other institutions and universities, contributing to the development of human resources, education and training in the nuclear field. Since 2016, it has been part of the International Atomic Energy Agency's (IAEA) "Internet Reactor Laboratory" program through the "RA-6 en Red" project, enabling remote participation of students and professionals in the region without access to a research nuclear reactor. [2].

1.2. The Visitor Program

1.2.1. Objectives of the visitor program

The RA-6 guided visitor program aims to establish a strong connection with society, with three key objectives: [3,4]

1. To stimulate the interest of high school students and the general public, fostering vocations in science and technology, and promoting a deeper understanding of nuclear technology and research lines.

2. To encourage visitors to contribute to the dissemination of knowledge in nuclear energy by providing them with the opportunity to interact directly with researchers.
3. To demystify and clarify preconceptions associated with nuclear energy in general, research reactors, their applications, and the benefits they bring to society.

1.2.2. Visitor Classification at the RA-6

Visitors are classified into three main groups according to their target audience:

- Educational Community: This includes primary, secondary, and university education levels.
- General Public: Represents a diverse and extensive group of visitors, encompassing different demographic profiles and characteristics.
- Official Visits, Expert Visits, and Institutional Interest Visits by CNEA (Protocol): This includes visits officially scheduled and those linked to specific institutions or interests of the National Atomic Energy Commission (CNEA).

1.2.3. Activities of the Visits Program

The main activity of the guided visits to the RA-6 is education and outreach. During these visits, the aim is to inform participants about the facilities, their applications, the operation of the reactor, and associated safety protocols. Additionally, the goal is to foster dialogue and public understanding about nuclear energy in general, its benefits, and its implications in society.

Specific activities during the visits include:

- Tour of the reactor facilities: Allowing participants to observe the operation of the RA-6 nuclear reactor from the visitor's room and understand its functioning.

- Educational talks: Given by experts in various areas applied to nuclear technology, providing detailed information about different lines of research, safety measures, and peaceful uses of nuclear energy in Argentina.
- Interaction with professionals: Providing visitors with the opportunity to ask questions and discuss topics from various fields with experts in biology, environment, geology, engineers, technicians, radiation experts, among others.
- Practical demonstrations: Showing concrete examples of nuclear energy applications in everyday life, such as in medicine, the environment, and cultural heritage.

Figure 1: Visitor's room, the day of its inauguration (Oct/2019) (Courtesy of CNEA - Community Relations Department).

1.3. Objectives of the Present Study

The main objective of this study is to conduct a preliminary evaluation of whether the guided visits program to the RA-6 reactor has a social impact linked to the program's objectives, as well as to interpret its potential influence on public perception of nuclear energy.

Furthermore, the aim is to analyze possible tools and indicators for quantitatively measuring the impact of the visits program, in order to examine how they contribute to public knowledge and understanding of nuclear energy through a comprehensive study of its impact.

2. MATERIALS AND METHODS

Based on the objectives set for this study, we analyzed the data collected from 2018 to 2023, focusing on the following points:

a) **Stimulating Interest in Science and Technology**: We assessed whether there has been an increase in the participation of high school and university students over the years. An increase in the number of visits by these groups was considered indicative of a greater interest in science and technology, especially in the nuclear field.

b) **Contributing to the Dissemination of Knowledge in Nuclear Energy**: We attempted to analyze whether visitors showed an increase in their knowledge about nuclear energy before and after the visits. Although we did not have pre- and post-visit surveys during this period, we explored the possibility of identifying whether there was dissemination within the visiting institutions or post-visit activities indicating a deeper understanding of the subject.

c) **Evaluating Social Impact**: We investigated whether the visits have influenced public perception of nuclear energy in their communities. We searched for publications such as newspaper articles and social media posts that could indicate a change in public perception.

Although we did not have surveys to assess perception before and after the visit, we explored other ways to gather information about social impact.

3. RESULTS AND DISCUSSIONS

Based on the data collected from 2018 to 2023 and in accordance with the three points outlined in the previous section, the following results are presented:

a) **Stimulating Interest in Science and Technology:**

The significant increase in the total number of participants in guided tours of the RA-6 reactor over the years indicates a growing public interest in nuclear technology. In 2018, there were 303 visits, and this number has increased considerably, reaching a total of 3062 visits in 2023. Although the tour program was initially planned to be implemented in 2019, its launch was postponed until 2022 due to the pandemic. Since then, a notable 80% increase in public interest compared to the previous year has been observed, highlighting a growing interest in this topic.

Table 1 : Distribution of visit types from 2018 to 2023. Source: RA-6 Technical Office.

YEAR	PRIMARY SCHOOL	HIGH SCHOOL	UNIVERSITY LEVEL	OFFICIAL VISITS	GENERAL PUBLIC	INSTITUTIONAL INTEREST	TOTAL VISITORS
2018	0%	39%	19%	5%	8%	29%	303
2019	0%	63%	19%	7%	3%	7%	454
2020	53%	25%	0%	9%	0%	14%	93
2021	0%	0%	0%	0%	0%	0%	0
2022	0%	31%	15%	25%	11%	19%	1703
2023	0%	42%	7%	10%	11%	31%	3062

Figure 2: Evolution of the total annual visitors from 2018 to 2023. Source: RA-6 Technical Office.

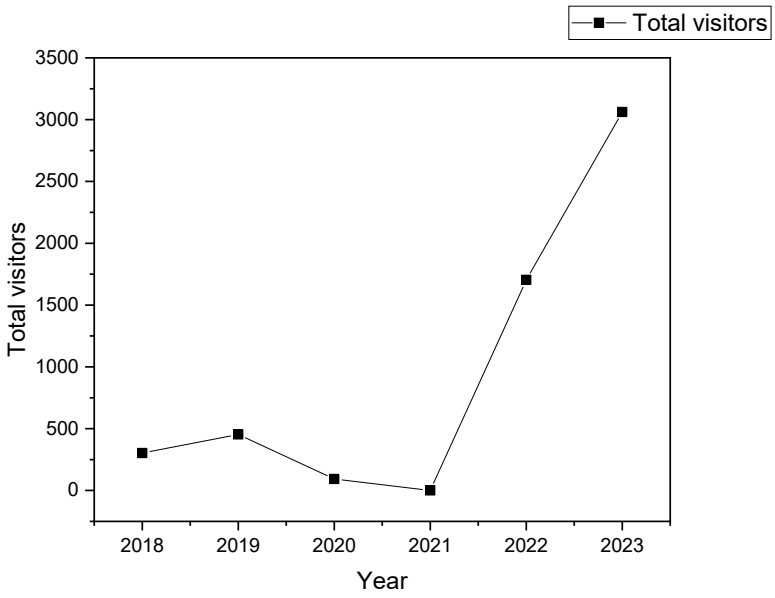
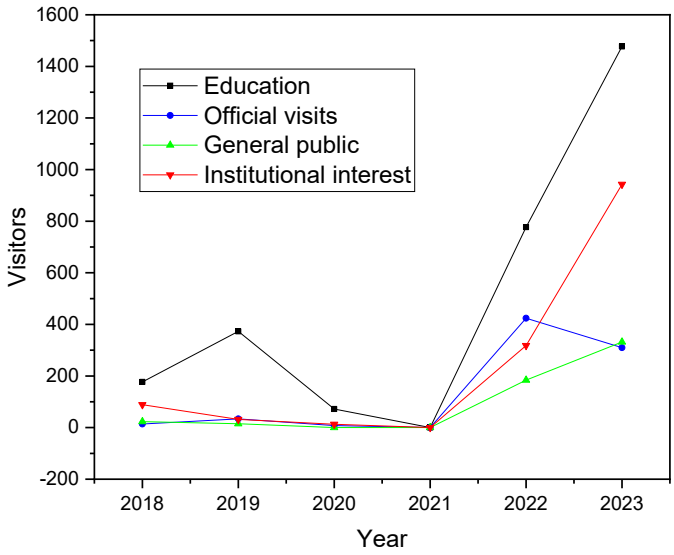


Figure 3: Evolution of different visitor groups over time. Source: RA-6 Technical Office.



As can be seen in Table 1 and Figure 3, there is a significant increase in the number of visitors, especially from the educational community, which nearly doubled in the last year. Similarly, there was a notable increase in official visits, with a slightly lower increment for the general public, which was around 60%.

The rise in the number of visitors, particularly from the educational community, suggests a growing interest in the topic of nuclear energy. This increase can be attributed to a heightened public awareness of the importance of nuclear technology, as well as the effectiveness of the guided tour program in disseminating information and promoting understanding on this subject. The provided data indicate a positive response and an increase in participation, suggesting that the tour program is achieving its goal of attracting a diverse audience and generating interest in nuclear technology.

Regarding the program's objective of fostering vocations in science and technology, a tangible impact has been observed among high school students who visited the reactor. Several of them have chosen to pursue their studies at the Balseiro Institute (IB) and other universities, expressing their interest in these disciplines after the visit. This result underscores the crucial role of guided tours in positively influencing the educational and career decisions of students, thereby strengthening their commitment to academic training in science and technology.

Figure 4: Visit of the Mega Programmers Winners (November 2023).

El Centro Atómico Bariloche recibió a estudiantes secundarios ganadores de un concurso de programación

Los ganadores del certamen "Mega Programadores ", organizado por la Universidad de La Punta, de San Luis, visitaron el reactor RA-6 y el Instituto Balseiro, entre otras instalaciones de la Comisión Nacional de Energía Atómica.

Official, Expert, and Institutional Interest Visits: They play a crucial role in highlighting nuclear technology and its applications, contributing to a broader understanding

and promoting dialogue at both national and international levels, representing over 40% of the total visitors in the last year.

b) **Contributing to the Dissemination of Knowledge in Nuclear Energy:**

As mentioned in section 3, we explored the possibility of identifying if there was dissemination within visiting institutions or post-visit activities indicating a greater understanding of the subject. Observing recurrent visits, especially from educational institutions, suggests a constant and growing interest in the RA-6 nuclear reactor as an integral educational tool. Specifically, it is noteworthy that, following the pandemic period, these annual visits highlight a lasting and positive impact on education. Among the recurrent visits, students from the early years of the University of Comahue, the University of Río Negro, and the National Technological University, among other educational institutions, have been identified. Likewise, numerous middle schools from both Bariloche and other Argentine towns have considered the visit to RA-6 as an important point in their study trips and institutional projects. These data reinforce the idea that the guided visits program to the RA-6 reactor fulfills its objective of being a valuable and attractive educational tool for students at all educational levels. Additionally, they suggest that the reactor visit experience contributes to a deeper and broader understanding of nuclear technology, which can have a positive impact on perception and attitudes towards this area of study and work.

c) **Evaluating Social Impact:**

The results obtained from the search for media coverage and social media repercussions reveal a high level of interest and dissemination associated with visits to the RA-6 reactor. Regarding the media, more than 30 notes related to visits to the RA-6 were identified during the year 2023. These notes were published in both national and local media, indicating widespread recognition and coverage of the event at the national level. In the digital sphere, over 100 publications were found on the internet and social media during the same period. These publications cover a variety of platforms, including YouTube, Twitter,

Instagram, Facebook, LinkedIn, as well as various university websites and official channels of various provinces and the national government. These results suggest that visits to the RA-6 reactor generate a significant media impact and wide online dissemination, contributing to increasing visibility and knowledge about nuclear technology and its applications. Furthermore, this dissemination may have a positive effect on public perception of nuclear energy by providing accessible information and fostering dialogue in society on this topic.

These results help assess the impact of guided visits and identify areas for improvement. Implementing tools such as surveys at the end of visits and pre and post-visit questionnaires, especially for the educational community, will be crucial for a more detailed analysis in the future.

4. CONCLUSIONS

The conclusions drawn from the analysis of guided tours data of the RA-6 nuclear reactor from the period 2018 to 2023 reveal several significant aspects:

Importance in the educational community: The tours offer a unique opportunity to inform and engage the educational community with nuclear technology, its applications, and its relevance in contemporary society. Furthermore, they can foster vocations in students, as demonstrated by the observed impact on those who chose to pursue studies in related disciplines after visiting the reactor.

Impact on public perception: Direct interaction with the reactor and nuclear energy experts provides participants with a deeper and more accurate understanding of the subject. Tours in the last year generated over 130 publications in media and social networks, positively influencing their perception and attitude towards nuclear energy, thereby contributing to a more informed and balanced public perception.

Promotion of transparency and safety: Allowing the public to observe the reactor's operation and become familiar with safety protocols promotes transparency and a more informed understanding of these facilities. This helps build trust and dispel potential concerns or fears associated with nuclear technology.

Encouragement of informed dialogue: Guided tours provide a space for the exchange of ideas and discussion about nuclear energy. This contributes to a more informed and balanced discussion in society, promoting constructive dialogue and helping to debunk misconceptions.

Despite limitations in evaluation tools, potential impact areas were identified, and alternative approaches were explored to assess the effect of the guided tours program at the RA-6 reactor. These preliminary findings underscore the importance of developing more comprehensive evaluation tools in the future to better understand the social impact of these tours and optimize their effectiveness in strengthening ties with society.

In summary, the conclusions highlight the educational, informational, and social value of guided tours to a nuclear reactor, as well as their contribution to greater public understanding of nuclear energy and its implications.

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CONFLICT OF INTEREST

All authors declare that they have no conflicts of interest.

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