Community awareness raising guidelines for RI utilization (D 5.3.2)

Szeged, 2019

"Tell me and I will forget;
teach it and I remember it;
I can grate and learn. "
(Chinese wisdom)

Developed by ELI-ALPS (LP) with the involvement of Expedient-ML Ltd. as external expert

Project co-funded by European Union Funds (ERDF, IPA)
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1. Short description of the project

Within the framework of the DTP1-1-1-184-1-1 RI2integrate project, during the 5th period of the implementation period, a project element "Awareness raising of the Young through Visitor Centre Activities" was implemented with the aim of providing support to young people in their careers, improving their knowledge of the links between natural sciences and the scientific infrastructures and their results which are directly relevant to everyday life, and provide an opportunity to assess how they can continue to be interested in it. An analysis of these experiences underpins the right choice of the final actions.

In the framework of the "Visiting young people through visitor center" project element, project partners organized pilot visits using visitor center activities of the different research infrastructures. During visits to the Visiting Center of the ELI Research Center in Szeged, 7th – 12th grade students attended one-and-a-half hours of experience-oriented, interactive activities, gaining insights into the operation of the research center. In Austria, visits were mainly organised for 16-18-year-olds studying mathematics-physics and to university students. According to questionnaires completed in the Czech Republic after the visits, the majority of the participants were high school students aged 16-17 years, who mainly pursue their studies in science specialization.

Access to the program made available was within the framework of the project, therefore participation in the program was provided free of charge to students and accompanying staff. The specific professional content of the visits was tailored to the specificities of the research institutes concerned, but the questionnaire, which was completed after the visits, was developed with a uniform content.

With the help of the questionnaire, the organizers asked about the experiences during the program, the opinions of the participating students and accompanying teachers, and the main areas of interest of the students in order to provide the best possible support for the relevant age groups in future similar programs.

The purpose of this study is to highlight the key research infrastructures underlying the pilot visits to the project and to summarize the experiences of the visits. Accordingly, the priority research infrastructures involved as partners in the project and their role related to awareness raising will be presented, along with related good practices; and the results of pilot visits organised within the framework of the project.

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A visitor center is not just a physical facility and exhibition. Its significance and effectiveness are complemented by various activities, such as workhops, lectures and events. Visitor Centers play a significant role in the education field, providing a venue that offers space for both informal and non-formal learning methods. However, this requires the implementation of an interactive educational activity that involves the use of modern methods such as gamification.

2. Priority research infrastructures in RI2Integrate

2.1 FH Joanneum, Graz

Among the universities of applied sciences in Austria, **FH Joanneum** is considered to be one of the leading universities with a commitment to innovation through research and development for the sake of sustainability and society. The institution offers 6 BSc and MSc related training programs in the field of IT, Business Informatics, Technical Informatics, Software Engineering, IT Law and IT Security, but also deals with IT research and development, e-public administration, broadband developments, information society. At the same time, the practical application of informatics in public administration is one of the focus areas of the institution. As part of interdisciplinary research projects, researchers are working to develop future technologies and methods. By working with businesses and institutions, FH Joanneum has vast experience in the technical, economic and design requirements of different frameworks.

As an applied research university, FH Joanneum is a strong driver of innovation in the field of research. It contributes to the development of ecologically, socially and economically sustainable concepts through regional and cross-border projects, combining creative solutions and a market-oriented approach for the benefit of society and the future.

Applied research ranges from the transfer of basic research results to innovative services and developments. This ensures a close link between research and education and is of great importance for practical application. The involvement of students in research projects is a crucial factor for the success of career-oriented and science-based training.

The University sees research as a multidisciplinary mission, a decisive approach for all its departments. On be half of FH Joanneuem, it is the Internet Technology Department that is involved in the project.

FH Joanneum's main research areas are:

- Applied computing

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- Software development and digital media development
- IT infrastructure architectures and IT security

2.2 ELI-ALPS Szeged

ELI-ALPS Szeged is a unique research institute based on optical lasers, which provides light pulses of the highest possible repetition frequency, even at attoseconds (10-18s), from terahertz to X-rays, with the highest repetition rate. Through its activities, the facility contributes to the scientific and technological developments required for high-intensity, high-power lasers.

The facilities of the facility not only accommodate laser equipment, secondary sources, target areas, laser products and other specialized laboratories, but also provide adequate working conditions for approximately 250 research and support personnel. Seminars, meeting and conference rooms, electrical, mechanical and optical workshops, and a library are also available. The facility has been designed with state-of-the-art principles, using state-of-the-art technology in terms of vibration levels, thermal stability, relative humidity, clean rooms and radiation protection conditions.

The Extreme Light Infrastructure (ELI) project is an integral part of the European plan to create the next generation of large-scale research facilities identified and selected by the European Strategy Forum on Research Infrastructures (ESFRI). It will be the first research infrastructure in the world to investigate the most intense light-matter interactions in the so-called ultra-relativistic domain. This will have a major impact on many areas of materials science, medicine and the environment. ELI is the first civilian large-scale high-performance laser research facility to be implemented in the framework of trans-European cooperation with the scientific community around the world. Hungary, the Czech Republic and Romania are implementing the project in parallel with the construction of three laser research facilities, each linked to a specific area of expertise, under a coordinated management and research strategy.

ELI-ALPS Szeged is the Hungarian branch of the cooperation, as well as a leading research and innovation institution in Hungary and in the Danube region and therefore plays a crucial role in the transfer of research results to the industry.

The facility is designed to avoid the 'cathedral in the desert' effect, and therefore aims to develop healthy research and development relationship with the business world through pilot projects. In addition, as an integrator of the planned ELI Science Park and the ELI Economic Growth Zone, the ELI-ALPS is an economic catalyst in the macro-region. The ELI-ALPS-

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based science park and adjacent incubator are home to knowledge-intensive businesses and spin-offs and start-ups. Supporting enterprise development for ELI-ALPS is also a key objective, especially for the creation of knowledge-intensive companies in the science park that seek to establish business relationships with local businesses.

2.3 Agroverzum Centre of Science and Fun, Martonvásár

The Agroverzum Centre of Science and Fun of Martonvásár is the visitor center of the Agricultural Science Research Center of the Hungarian Academy of Sciences. It is both a knowledge center and a science playhouse. Its main goal is to raise awareness of agricultural sciences and to provide scientific knowledge in a clear and enjoyable manner that encourages thinking.

The interactive permanent exhibition of Agroverzum presents phenomena that are being researched at the Agricultural Research Center. These include soil research, plant breeding, the scientific basis for pest control, and research needed to maintain healthy livestock and combat emerging diseases. During the visit visitors will have the opportunity to use interactive tools, watch animations, watch movies and try different games. In addition, they gain insight into the world of scientific research, in all its phases.

The scientific programs organized by the institute introduce visitors into the world of science in an extraordinary way. Visitors can choose from the possibilities offered by the BioLab and the Scinetific playground, or participate in discussions of the Scientist's Café and interactive exhibitions of Science Fairs.

2.4 ELI Beamlines, Dolní Břežany

As part of the Extreme Light Infrastructure (ELI) project, ELI Beamlines is located in Dolní Břežany on the outskirts of Prague, the capital of the Czech Republic. ELI Beamlines is designed as the high-energy, high repetition-rate pillar of the Extreme Light Infrastructure (ELI). The top-level goal in implementing the project, as endorsed in the ELI White Book, is to establish a high-energy beam facility, responsible for development and use of ultra-short pulses of high-energy particles and radiation stemming from relativistic and ultrarelativistic interactions. ELI Beamlines is intended to address one of the "grand challenges," specifically in the generation of ultra-short pulses of energetic particles (>10 GeV) and radiation (up to few MeV) beams produced from compact laser plasma accelerators, and is expected to support the "Ultra-high field Science, i.e. access of the ultra-relativistic regime".

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The main mission of ELI Beamlines facility is to become a truly multidisciplinary, user-oriented infrastructure to perform revolutionary scientific experiments and applications in different areas including physics and astrophysics, chemistry, biology, material science, medicine etc. combining advanced synchronized ultra-intense short pulse lasers and secondary sources of particles and x-rays.

ELI Beamlines facility will provide research opportunities at a large portfolio of world-class secondary sources, driven by ultra-intense lasers. These secondary sources, partially based on entirely new concepts, will produce pulses of radiation and particles of highest intensity and beam quality, including electromagnetic radiation over a broad spectral range and charged particles like electrons, protons and ions. A wealth of novel applications is foreseen.

3. The role of priority research infrastructures in awareness raising

3.1 Visitor Centre functions of priority research infrastructures

Today, the world's more than 3,000 science centers attract more than 300 million visitors each year. Twenty-five years ago, barely ten percent of these institutions existed. There is a worldwide movement around us that is spreading unstoppably, growing year by year, not just because of the special attractiveness of scientific centers. The social and economic aspects of the role they play through their visitor center activities also contribute to their success.

There is ample evidence that science centres have a significant impact on their environment through their visitor centres:

- Science centres contribure to a better understanding of scientific issues and help to increase the scientific knowledge of residents and visitors.
- Museum experiences, both exhibitions and programs, are extremely memorable. As a result, the vast majority of visitors bring home lasting memories of the experiences having gained during their visit. All this contributes to the continuous deepening of scientific knowledge. Studies show that visitors are able to recall exactly what they have experienced during their visit six months after the visit, and that about 30% of adult visitors associate scientific experience with everyday life.
- The immediate, short-term outcome of a visit is an increase in knowledge, skills, motivation and interest. Long-term effects include a change in attitudes and awareness, which occurs weeks or months after the visit. In this regard, visitors always have a new perspective as a result of the visit and a greater awareness of scientific issues / phenomena.

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- The activities of visitor centers have a positive influence on visitors' attitude towards science and technology. Visitors of science centers are more likely to become citizens with scientific and technological knowledge. Frequency, length and duration of visits have a major impact on the scientific literacy of visitors.
- Cognitive Impact: Salmi (2003) conducted scientific tests with groups of students who reguralrly visit scinece centres, and also groups who do not participat in science centre visits. Using the science center exhibitions, he found clear positive cognitive learning effects. Miller (2004) found that informal learning opportunities, including science museums and science centers, contribute to citizens' scientific literacy.
- Attending interactive exhibitions has increased students' scientific knowledge regardless of their school performance. It also bridged the gender gap in learning. As a general experience for the visitors, it is not only the content of the exhibitions that is to be positively evaluated as a learning opportunity, but also the new vision taking shape as a result of the visit.
- Visits to science centers in all age groups have a positive impact on student motivation, but the results show that the impact is most positive among primary school students. Intrinsically motivated students achieve better cognitive outcomes and tend to use learning techniques that contribute to the long-term acquisition of knowledge. During the visits it can also be observed that students with learning difficulties are also motivated and interested.
- In connection with visits to science centers, it can be shown that they have a positive influence on children in their career choices. The results show that informal learning situations such as visits to science centers have a significant impact on the career choices of university students. Most of those in science careers report visits to museums and science centers during their early life as a child, and these were defining experiences orienting the towards the world of science. Between 85% and 92.9% of those with a scientific career report visiting planetariums, aquariums, zoos, science museums or museums of natural sciences as the most memorable early informal educational experience. Science centers and exhibitions are also leading the way in establishing links with the early stages of school education.
- Through their visitor center activities, science centers are part of cultural tourism and thus of the tourism industry. Therefore they make a significant contribution to the local economy. Being part of cultural tourism, they also contribute to broadening the diversity of educational opportunities.

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- Their positive effect is also reflected in the fact that, as a general trend, a new scientific facility is often constructed alongside rehabilitation-revitalization efforts in a given area, revitalizing brownfield / industrial areas.

The program developed by the project provides support for young people in their career choices raising their knowledge in the field of natural sciences, and contributes to connecting scientific infrastructures and the scientific results to everyday life. It also provides an opportunity to assess how they can continue to be interested in this endeavor, thus helping the work of teachers involved in formal education

An important goal during the implementation was that in cases where accompanying teachers were involved in the programs, teachers would be sensitized, and as a result of the visits, they would accept the complementary, supportive, or even synergic opportunity provided by the program. According to the preliminary survey, there was an increased interest and willingness of school principals to participate in the program, which may determine the long-term attitude of the teachers. As the preparation of programs for students depends largely on teachers, it is particularly important to reach out to this target group.

3.2 Good practices for visitor center activities

3.2.1 CERN (https://home.cern/)

CERN, situated in the the French-Swiss border area near Geneva, was founded in 1954. Here, physicists and engineers at the institution study the basic structure of the universe. They study how particles interact with one another and gain insight into the basic laws of nature. To do this, scientists use the largest and most complex scientific tools in the world. In addition to extensive scientific research, the center places great emphasis on collaboration with students and their teachers.

Teachers are offered summer training programs, which last 3 days to 3 weeks and aim to improve teachers' knowledge and skills related to the latest developments in particle physics and related fields. Training camps should also give them an opportunity to learn about the international research environment. The programs are supported by experts, and teachers have the opportunity to meet colleagues from around the world.

CERN also offers free guided tours for individual visitors and student groups. Guided tours allow visitors to familiarize themselves with CERN's historic parts, the units responsible for running the institution, and the areas reserved for visitors. The tour is complemented by

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audiovisual elements. They also offer two permanent visits, which are available without prior registration.

From the point of view of visitor centers, the most interesting initiative of CERN is the S'Cool LAB. Located in CERN, this center offers high school students and their teachers the opportunity to participate in practical and theoretical particle physics experiments. Through these programs, students can individually and scientifically discover how to apply their knowledge in a new environment. Visiting students work with CERN scientists to gain insight into the life and work of the research institute. S'Cool LAB offers three activities: S'Cool LAB Cloud Chambers, S'Cool LAB PLUS + and S'Cool Lab Summer CAMP.

In S'Cool LAB Cloud Chambers, students have the opportunity to build a cloud compartment, which is a particle detector, and then track the particles visible from the compartment. Students will be made aware of the importance of maintaining lab cleanliness and learn how to be responsible users. The whole process and the group discussion are facilitated by a specially trained instructor from the CERN scientific community.

In S'Cool LAB PLUS +, high school students can take part in two particle experiments. One is a cloud chamber workshop and the other is a S'Cool LAB experiment, such as building an electron beam and studying electrons, operating an X-ray machine and studying X-ray absorption with a fluorescent screen and pixel detector scintillation detectors to understand the positron in PET emission tomography principles and determine the source of a positron (Na-22) and measure the electrical resistance of a normal conductor and a high temperature superconductor. They work in groups of 2-4 people and study particle physics. During the session they formulate their expectations, observe the experiments and then discuss the results. The session will be led by a specially trained instructor from CERN's scientific community. In addition to studying, students contribute to research in science education by completing questionnaires, interviews, and testing new S'Cool LAB assignments.

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source: https://scool.web.cern.ch/

CERN also offers a S'Cool LAB Summer CAMP for high school students. Approximately 30 selected students over the age of 16 from all over the world attend the two-week camp. During the camp, lectures and educational materials are provided, students work on their own research projects and visit research facilities. In addition, CERN offers students the opportunity to complete part of their university education and, in the case of high school students, the professional part of their education here, in order to familiarize students with STEM disciplines in the context of CERN, contributing to their understanding science and the development of their skills in a high-tech environment.

In addition to on-site visits, CERN also provides a wealth of scientific information for anyone interested in learning about the Center's research topics. CERN visits are available to children over the age of 12, but an interactive online learning platform for children is also planned. On this site, students can play videos made about CERN and its activities, interactively discover the lab and the universe, and they can also play. (http://www.cernland.net/).

3.2.2 Goddard Space Filght Center and Goddard Visitor Center (https://www.nasa.gov/centers/goddard/visitor/home/index.html)

The Goddard Space Flight Center and its Visitor Center are located in Maryland. The Goddard Space Flight center plays a crucial role in NASA's missions, gathering information for scientists through more than 50 spacecrafts. Missions support multiple disciplines, including Earth Science, Solar Science and the Sun-Earth Environment, Planetary Research, and Astrophysics.

The Goddard Visitor Center illustrates the center's innovative activities in the areas of Earth Sciences, Astrophysics, Heliophysics, Planetary Science, Engineering, Communication and Technology Development. The center pays special attention to visitors with disabilities offering

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sign language interpreters, CART services, and specially designed walking tours for disabled visitors, making science accessible to them. The center also organizes events for special occasions such as NASA's 60th anniversary and there are also recurring events available at the center.

As a free program, the Sunday Experiment is organised every month. The program features world-renowned scientific and engineering research and technology development by the Goddard Space Flight Center. The program is aimed at children between the ages of 5 and 10 and their families. The center also introduces the major scientific missions of the Goddard Space Research Center, with the purpose of providing visitors with the opportunity to explore the center and inspire them by interesting and entertaining activities.

The center also hosts modeling rocket launches, which are free to visit. The event is for people who want to build and launch their own model rocket. Visitors have the opportunity to bring their own model to the center where they can buy rocket-building components such as engines and supplies, but the center also offers the opportunity to purchase their rockets on site. During the sessions, participants will receive advice from experts at the center. It is also possible to attend the event as a passive participant.

Source: https://www.nasa.gov/content/goddard-visitor-center-events-and-programs

It is not the Visitor Center, but the Goddard Flight Center Educational Resource Center, where teachers learn about and use NASA's educational programs. The Aerospace Center works with teachers from all types educational institutions, teaching at any levels. The purpose of the Educational Resource Center is to share the knowledge accumulated by NASA. The

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center's work involves NASA scientists and engineers with their expertise, and the scope of their activities range from program design to implementation. The Educational Resource Center also introduces educational technologies, trainings and educational products to workshops organised on site. In order to help teachers in their professional development, NASA's unique materials are used to improve their professional skills in areas such as Earth sciences, space research, aerospace industry, technology and engineering to meet curricular needs. Educators will be introduced to curriculum design challenges, and will have access to rocket launcher models, mass and weight kits, and free publications and products such as posters, videos, lithographs, DVDs, NASA TV programs, CDs, curriculum guidelines.

The Goddard Space Flight Center also offers various educational programs that focus on STEM training. The center organizes public events and offers experimental learning opportunities, resources and opportunities to explore challenges in STEM areas. Students have the opportunity to directly contact staff members of the International Space Station. For high school students, minorities, and underrepresented populations, the center also provides a summer program to introduce the technical work environment, Goddard missions. At these occasions, participants have to opportunity to make observations, and to engage in interactive activities. High school students can paticipate in on-site experience during the school year, provided through their own educational institution. College students can participate in mentored, experience-based research, and the center follows a teaching practice that also demonstrates how to use NASA-provided content and materials in classroom settings.

The Goddard Space Flight Center has an internship program and scholarships are available for students. These programs enhance the capabilities, diversity, and size of the future STEM workforce in the US. The internship is available from high school to postgraduate level and provides students with the opportunity to participate in research and experimental learning activities under the guidance of NASA mentors. The center also offers career opportunities for students enrolled in a certified training program. These students will have the opportunity to familiarize themselves with the work of the Space Research Center during the training period and, if successful in completing the training program, may receive a permanent or temporary employment offer from the Agency.

3.2.3 Petnica Science Center (http://petnica.rs/)

The Petnica Science Center in Serbia is a unique, alternative and future-oriented school founded in 1982 by a group of students who wanted to participate in developing a new model in science education. The center identifies talented young students and helps them acquire critical thinking skills, contributing to their understanding and applying advanced concepts in

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modern science and technology. The Petnica Science Center is a non-governmental and wholly non-profit institution which exists thanks to financial support by a wide range of Serbian and foreign students, organizations, schools and companies.

Source: http://petnica.rs/

The Petnica Research Center organizes a number of different programs each year, such as camps, courses and workshops, to raise awareness. These programs are supervised and coordinated by Serbian university professors, researchers and research assistants. The programs are mainly offered to high school students and run in annual cycles. The first programs are implemented in four complementary groups. New students first take a one-week winter course in intensive theoretical work (lectures, demonstrations, discussions).

Spring courses are shorter, focusing on practice-oriented training on how to use equipment, how to do fieldwork, data collection and process data collected through statistical methods. During the two-week summer science camps, students are free to work on small and sometimes not so small research projects. During this time, they will gain valuable experience in real scientific work, knowing all the difficulties and problems encountered in professional work. Autumn courses provide students with the opportunity to meet again, discuss results, deepen their knowledge, and participate in research lectures held by researchers, presenting researchers with their own work and the latest results from modern science and technology. Participants who successfully complete the training will be invited to the Petnica Annual Student Conference, where they will be able to present their research results to other participants, collaborating teachers and scholars.

For the Petnica Science Center, awareness raising is addressed through educational and mentoring programs that focus primarily on high school students and early-stage researchers. The programs allow students to participate in the activities of the research center and receive professional assistance in carrying out their own projects. Thus, in Petnica, awareness raising is inclusive and focuses on motivated young people who wish to become scientists.

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3.2.4 ELI-ALPS Szeged (https://www.eli-alps.hu/)

ELI ALPS Szeged participates in the Researchers' Night series, initiated by the European Commission, to raise awareness. The event, often referred to as the Science Festival, is funded by European Union funds and aims to strengthen the overall competitiveness of the Community. Encouraging young people to participate in scientific activities and build their scientific careers contributes to this end. The Researchers' Night will present the latest research findings, the tools employed and the importance of research and development infrastructures and their role in everyday life and in society. From the youngest generation to the oldest, anyone can participate in the event free of charge. Researchers' Night has a long tradition in Hungary. It usually takes place at the end of September, on a given day, from early afternoon until late at night.

Source: https://www.delmagyar.hu

3.2.5 FH Joanneum (https://www.fh-joanneum.at/)

The University of Graz in Austria has several approaches to raising awareness. In doing so, it is open to a wide range of stakeholders, seeking to share knowledge from children to local businesses. Implemented as a 3-year project between 2009 and 2012, the Knowledge for Business in Border Region (KBB) is managed by the Institute for Systems Science, Innovation and Sustainability at the University of Graz. The main objective of the project was to establish a mechanism to promote the development of competitive enterprises, especially small and medium-sized enterprises in the Austrian and Slovenian border regions.

The Institute aims to provide appropriate methods for technology transfer, training consultants and the implementation of specialized technology transfer projects. The aim of the project was to facilitate the practical use of research and development results by establishing and identifying networks between relevant institutions and possible future areas. Among the main target groups of the project we find border regions and researchers. The project organized

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various events, including training to improve knowledge and technology transfer. It also facilitated bilateral cooperation between science centers, industry and small and medium-sized enterprises. Another result of the project was the establishment of a partner network involving all stakeholders in the field of knowledge and technology transfer.

Source: https://www.joanneum.at/en/get-to-know-us/press/press-photos/

The KBB project approached awareness raising by improving communication and collaboration between market players and R&D infrastructures. It aimed to increase knowledge and technology transfer through transfering research results to companies in order to improve their adaptability. The target group of the project was those companies located on both sides of the Austrian-Slovenian border.

3.2.6 Casa Expelimentelor (http://www.casaexperimentelor.ro/)

In Romania, Casa Experimentelor, or House of Experiments, is a noteworthy institution for raising public awareness of R&D results. Casa Experimentelor started operations in January 2016 and is open seven days a week. The institution organizes permanent exhibitions of scientific equipment, its aim is to improve education and knowledge by implementing the learning-by-doing principle. The aim is to provide a high level education, raise interest in science and knowledge, and effectively support educational institutions.

Casa Experimentelor, in its basic concept, offers a wide variety of interactive experiments that allow visitors to experiment, discover new knowledge, and ask professionals questions about certain phenomena. It is an opportunity to discover the world of technology directly through hands-on experimentation, contributing to increase interest in the practical experience of the theoretical knowledge acquired at school.

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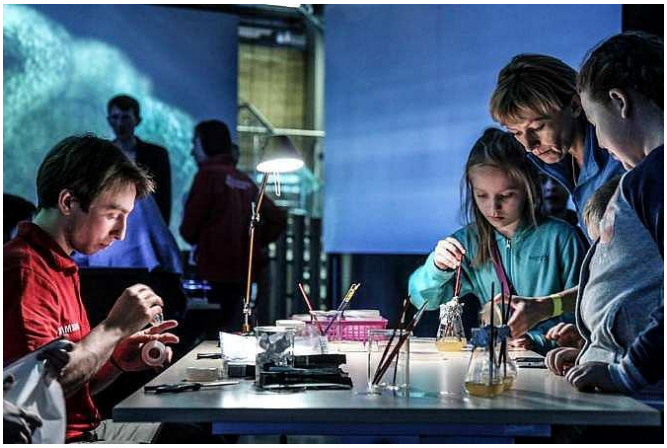

Source: https://www.romania-insider.com

It is estimated that more than 50,000 children, students, teachers, parents and other adults have visited Casa Experimentelor so far. Since its opening, the institute has become a popular destination for Bucharest residents and communities of other parts of the country.

3.2.7 BLUE SMART (https://bluesmart.hr/en/ocean_related_issues/aquaculture/)

In Croatia, BLUE-SMART (Blue Education for Sustainable Management of Aquatic Resources) is a program run by the Department of Ecology, Agronomy and Aquaculture at the University of Zadar. To implement the project, the department cooperates with various NGOs, such as WWF Adriatic and private companies such as Cromaris, to implement the project. The overall aim of the BLUE SMART program is to develop new skills and competences in the blue economy sector and to increase the employability of current and future workers in the wider Zadar area. The activities carried out by the project have two specific objectives. One of them is the development of a new training program at the University of Zadar, which will allow participants to continue their studies in the field of sustainable management of aquatic ecosystems. The other endeavor is to develop a vocational training course that introduces participants to the practice of sustainable aquaculture. The legitimacy of the BLUE-SMART program is based on the fact that in Croatia the blue sector plays an important role in economic life and the sector also has a significant demand for skilled labor force.

The target group of the project is primarily students and young people, in addition to workers already employed in the blue economy. The aim of the project activities is to improve training opportunities for new generations of students and professionals, with an emphasis on skills needed in the blue economy. For those already employed in the sector, the program provides new skills that can be used in their daily work.

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Source: https://bluesmart.hr/

The BLUE SMART program, initiated by the University of Zadar, is a good example of raising awareness through educational programs and training.

3.2.8 Palacky University: Fort Science (https://www.pevnostpoznani.cz/english/)

Fort of Science is the Interactive Science Center of the Olomouc Palacky University, considered by many to be an oasis of science. It combines the unique atmosphere of the venue with the ability to educate and inspire students, children and their parents. The architecturally exceptional building used to be an army warehouse in the past, but in 2015, the fort was transformed into a haven of knowledge, education and science.

Fort of Science employs a number of interactive and general exhibitions, digital planetariums, and games to enhance knowledge and logical skills. Among them tools such as a giant brain and eye model, gyroscope for pilots and astronauts can be mentioned, as well as the possibility of taking part in science experiments, in addition to the organization of school programs. Through the programs, the center aims to introduce new ways of learning to visitors. To this end, experiments and interactive models are used to illustrate natural laws and phenomena, all of which help visitors discover science through practical activities. The center is an ideal place to hold lectures on physics, biology or geography, so the overall goal of promoting science and raising awareness can be achieved through the implementation of innovative programs.

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Source: https://www.flickr.com/photos/pevnostpoznani/albums

Fort of Science is a noteworthy example of awareness raising. Its purpose is to educate different groups, although it is mainly focused on children, students and teachers. It is meant to increase visitors's knowledge through practice-oriented methods, basically using a learning-by-doing approach. This interactive learning method increases participants' commitment to a particular topic and increases the effectiveness of their learning.

3.2.9 Center Eksperimentov Maribor (http://www.ektc.si/en/about-us)

In Slovenia, the Maribor Experimental Center is a good example of how high school students can gain experience in the field of science through participatory methods. Like many newly developed science centers, the Maribor Experimental Center is using new pedagogical methods to improve visitors' knowledge and practical skills. The center offers a permanent collection of about 50 experiments designed to explore different fields of science (physics, mathematics, engineering, chemistry, biology, etc.). The demonstration gives visitors the opportunity to conduct test experiments on their own.
The initiative is aimed at young people, but does not exclude members of the target group who have special needs due to their higher levels of competence, career orientation, interest in non-formal education and special content.

Source: http://osobdravinji.si/index.php/galerija

The Institute also focuses on promoting science and knowledge, with a particular emphasis on science, modern technology and the implementation of research, development and innovation activities. The Maribor Experimental Center was set up to work with young people and children, schools, teachers, youth centers and others interested in promoting science and knowledge. The institution is a good example of raising awareness of experimental pedagogy and methods of learning-by-doing by transferring knowledge from different areas of science to visitors through the participation of visitors in different activities.

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4. Target groups of visitor centers

4.1 Definition and segmentation of target groups

The visitor center's target groups can be divided into three main groups: students, teachers and the general public. These groups may be divided into smaller subgroups and the visitor center shall provide different activities for each subgroup.

Segmentation of the target groups (Table No. 1) is crucial for the implementation of the visitor center. The visitor center is primarily aimed at reaching young people, so the most important target group is the student group. Within this group, a distinction can be made between primary, secondary and university students. As high school students study natural sciences in more detail, they are much more aware of whether or not they are interested in science. Therefore, within this group, a distinction can be made between students with a scientific interest and those with a different orientation. The third group of students is university students, which can be divided into three groups: science program participants, students participating in a teachers training program, and students with other field of specialisation. By connecting to students, teachers are also a key target group, considering that they are the most important players in the learning process of student. Despite the fact that the visitor center focuses its activities on the youth, its role in raising awareness amongst the general public is also significat, therefore local residents and scinece tourists must also be identified as its target group.

Students	I.	Primary school students, age 10-14 years
	II.	Secondary school students with special interest in science age 14-18
		Secondary school students with interest in other areas, age 14-18
	III.	Higher education students participating in science education
		Higher education students participating in teachers training program
		Higher education students with other field of specialisation
Teachers	I.	Primary school teachers
	II.	Secondary school teachers
	III.	Teachers in higher education
General public	Local residents	

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	Scinece tourists (national, or international)

Table No. 1.

4.2 Needs and expectations of target groups of visitor centers

Elementary school students need to be addressed in an easy to understand, playful way. These students are only at the beginning of the scientific learning process and are therefore unable to recognize complex relationships between the various disciplines and to understand complex models. For that reason, everyday use cases realted to a given research infrastructure topic need to be highlighted by simple but interesting experiments for them. The goal is to raise their interest in science and to show that science is fun. During their visits, they must learn that science is not just a privilege for few people, and if they are interested in an area, they also have the opportunity to become a scientist.

High school students can be divided into two basic groups: a distinction can be made between students with a scientific interest and those with interest in other fields. This approach is much more effective than categorizing students in line with their year of study, or learning outcomes. In high school, all students usually get to know the same disciplines in subjects such as biology, physics, chemistry, geography, mathematics, and computer science. Thus, the progress of students who are interested in a particular area is greatly hindered by students who are not interested in that specific discipline, and who are particularly bored during classes of the particular subject. At the visitor center, at least two different programs must be designed to meet the needs of these two groups. For students with a scientific interest more complex models, scientific experiments and results need to be presented, and they must be provided by opportunities for interactive activities. Students with interest in other fields of specialisation on the other hand need to have a program that focuses on the general presentation of the research infrastructure and its local role, as well as on how to bring scientific results to market and how these results become part of everyday life. All of this can stimulate their interest in science and encourage them to engage in science-related activities, but if they fail to do so, they will gain useful insights that they can then use in other areas of education.

There is also a need for a variety of programs for **university students**. Students in science education should have access to the latest scientific results. They are the ones with detailed scientific knowledge, so they can understand complex processes and models, and as a result, the visitor center is an important opportunity for them to contribute to improving their knowledge and skills. They may also participate in scientific activities, carry out experiments or even carry out smaller projects, provided that the research infrastructure allows them to do so. Students participating in teachers training programs should be presented with the

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educational aspects (informal and non-formal learning, game creation, STEM education, etc.) as well as the facilities offered by the visitor center with the option to participate in the activities of the center. Students in other degree programs may learn about the role the research infrastructure plays in the region, for example, students in business education will learn about the economic potential of a research infrastructure, or law students will learn about the legal aspects of applying scientific results. In addition to visitors to the center, these students should also be given opportunities for summer internships and volunteering. As many foreign and exchange students are involved in university education, it is important that the visitor center offers programs not only in the local language but also in English.

Teachers are an important target group for visitor centers. In primary and secondary education, visits are organized by teachers, but their role is much more complex. By providing students with basic information about the research infrastructure and what to expect during the visit, they contribute to a better understanding of the knowledge transferred during the visit by providing prior information. After visiting the center, a follow-up activity is organized for the students of the school to discuss and gather experiences from the visit. All of this contribute to making the visitor center experience become part of the students' knowledge and skills. During the visit, they will learn about new scientific achievements and various teaching methods that can be used in their daily work. Because of the fact, that university students are more independent, the role of teachers in higher education is limited to organizing visits and other activities, and they act as mentors and coordinators for students pursuing scientific activities at the center. At the same time, they can learn about the new scientific results during the visits.

Local residents and **science tourists** are also the target group of the visitor center. During their visits, they typically take guided tours to explore the research infrastructure. They are the ones who generate revenue for the visitor center by purchasing admission tickets and small souvenirs. In case of larger research facilities, it is important that, besides the local population, they are able to attract visitors from neighboring countries as well, so it is particularly important that exhibitions at the center are available in the native language of visiting tourists.

5. Actors of awareness raising

The Triple Helix model of innovation sees interaction between R&D institutions, business and governmental organizations as the main drivers of socio-economic development. The three elements of the model interact with each other in close cooperation and in specific roles, which become the key determinants of innovation processes.

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The primary role of universities is the education of individuals and basic research. Therefore, the interaction between universities and industry initially moves around these two focus areas. In a linear model of innovation, universities need to do the research industry will rely on to produce commercial goods. Other interactions involve industry leaders and academics in both sectors. The movement of people between universities and industry at different points in their careers is an important factor in knowledge transfer. Further knowledge transfer between universities and industry will take place through informal communication, conferences or industry interest.

The strength of government-university interaction depends on the general relationship between government and higher education policy. The extent of these interactions can best be interpreted along a spectrum. When higher education is predominantly public, such as in continental Western Europe, the government exerts greater influence on universities and the research they carry out as the main source of funding. In the United States, universities are more independent of government influence, though they also receive public funding.

The relationship between governments and industry depends on the government's market attitude. In liberal economies, the role of the government is limited to preventing market failures. On the other hand, where the government is more involved in the economy, the government's role is to regulate the industry. This is also identifiable as the two ends of a spectrum and leaves room for significant differences in circumstances and disciplines. One of the key roles of the government in the interaction with industry is the establishment and implementation of the intellectual property regulation.

The Triple Helix model is the basis for the Quadruple Helix model. The new model, along with university-industry-government, adds a fourth helix, namely the media, culture-based community space and civil society (Carayanniset al. 2012, Carayannis-Campbell2012). The four-fold spiral model embraces both civil society and users of innovation. In the Quadruple Helix model, just like in its predecessor, roles and responsibilities of the spheres, which may vary in time and take different forms, are also complementary.

Within the framework formed by the Quadruple Helix model, the aim is to bridge the gap between innovation and civil society. The emergence of the new model was indicated by the tendency that emerging technologies do not always fully meet the needs of society, which significantly limits the potential impact of these new technologies. The new model therefore places particular emphasis on universities' social responsibility, in addition to their role in education and research leadership. The activities of research institutes and research infrastructures, which are also part of the R&D institutional system, fall within this framework. Similarly to the role of universities, the Quadruple Helix model also puts and emphasis on the

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importance of knowledge transfer for these institutions, since by the emergence of a fourth safe, that is civil society and users, the necessity of transfering significant knowledge accumulated in institutions to the wider public arises.

Source: https://tudaspark.debrecen.hu/index.php/hu/innovacio1

6. Main aspects of awareness raising

6.1 Infrastructure

The visitor center must be located within the research infrastructure or within walking distance at the most. Arrival and departure of vistors must be properly organized so that the day-to-day operation of the research facility or the arrival of other guests is not disturbed. Logistics issues also need to be taken into account as student groups usually arrive by bus, therefore access to buses and the parking area is a must.

The design of the visitor center shall be consistent with the design of the center as a whole and shall reflect the scientific environment in question. Posters can be placed on the wall and on the models, focusing on the specific research topics of the research facility. If the conditions at the research facility are satisfactory, guided tours can be organized for visitors. This requires a safe but interesting route for visitors within the facility. If this is not possible, the facility can be presented in an interactive way (audio-visual tour) so that the facility can be brought closer to visitors.

The area of the visitor center should be subdivided into different parts, allowing for different activities to be carried out simultaneously. The center should include an exhibition space where the history of the research facility and its current activities, models, equipment and tools used by the scientist can be demonstrated. The whole exhibition must be organized in an

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interactive way. Information on the research facility needs to be presented through audio-visual narration, and an interactive approach is also important when presenting the tools. Long texts and explanations should be avoided as most visitors do not read or listen to them.
In addition to the exhibition, there is also a need for educational space in the visitor center where visitors (mostly students and their teachers) can engage in scientific activities. This can be a large hall that can be subdivided by furniture or even several smaller, separate rooms in the center. Whichever option the facility chooses, the room should provide space for lectures, teamwork, or space for individual work. An important aspect in the design of the training venue is t create a friendly atmosphere, which can be achieved by the use of properly selected furniture, posters, colors and inscriptions.

6.2 Awareness raising activity of visitor centers

The center should provide students with educational activities that do not take place in the school environment. Although these visits provide an opportunity to complement formal education, due to the short time spent at the research facility, they generally do not influence the level of education of the students (Lin & Schuman 2016). For this reason, the visitor center's programs need to be supplemented with prior information and follow-up activities, and visits must be repeated on a continuous basis. Through a repetitive system of visits, a process can be created that provides opportunities for students to visit the center from primary to higher education and to gain new and relevant knowledge at all times.

6.2.1 Primary school students

Prior the visit, primary school students should be provided with preliminary information about the facility and the activities carried out there. This can reduce students' resistance and relieve their shyness, thus making them capable to enjoy their visit. In their case, the purpose of the visit is to show that science can be fun and interesting. In order to achieve this goal, it is essential to avoid creating stressful or competitive situations.
The visit should begin with an interesting audiovisual presentation of the research infrastructure in the presentation space. After that, a You a short walk through the exhibition space is suggested, where the instructor will share interesting details about the facility and what participants can see during the visit. This is followed by the interactive part of the visit. This requires the development of different types of programs according to the students' grade, knowledge and level of interest, and their disability, if any. When organizing a visit, teachers should consult program details with the visitor center, and select the most appropriate items for visiting students.

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In the interactive part of the visit, the instructor presents the experiment to the children. The experiment must be easy-to-understand and not too long, and must relate to real life. For example, the logic of how a device used in everyday life works can be demonstrated. 2-4 experiments may be presented per visit. After the instructor has presented the experiment, children should be given the opportunity to try the instrument themselves or try the experiment again under the supervision of the instructor and the teacher. Special needs of children with disabilities should be taken into account so as to be given the opportunity to discover. The total duration of the visit should be no more than 1,5-2 hours.

After the visit, when students return to their school, or in the days following the visit, teachers need to discuss with students what they saw in the visitor center. This is to ensure that the experience gained at the visitor center is used to the fullest extent possible and becomes part of the students' knowledge and skills. Students should also be asked to complete a questionnaire and share their views on the visit, as their feedback plays an important role in developing the visitor center further.

6.2.2 Secondary school students

High school students can be divided into two groups based on their interest in scinece and level of knowledge. Unlike primary school students, high school students have more detailed scientific knowledge and are able to work independently. As a result, in addition to organized visits, they can also participate in high school leisure activities that place greater emphasis on individual work.

Prior to the visit, students must be informed in advance of the facility, so they may have prior knowledge when arriving at the center. Once they arrive, they have access to similar programs as elementary school students. As a first step, the facility may be introduced through an audio-visual presentation or, if the conditions of the research infrastructure are appropriate, they may take a guided tour of the facility. They can then visit the interactive exhibition.

During the interactive sessions, high school students can choose between two activities. One focuses on experimentation and research, the other on the everyday use of research results. For the experiments, the students should be divided into smaller groups (3-5 people) and provided with the necessary tools and materials. With the help of the instructor, the experiment should be planned and performed, the results closed and discussed with each other and with the instructor. The process should be based on knowledge from formal education, but the principles of non-formal education should be applied. During the program, students may use simplified equipment of the facilities, or, if this is not possible, must be provided with other equipment related to the research facility's research topic. The teacher has a crucial role in

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the process. While not interacting with groups on a continuous basis, he/she follows their work and intervenes when necessary. For example, at the end of the design phase, after the experiment, or when it becomes apparent that a group got stuck at a certain point of an experiment. The role of the instructor is not limited to providing knowledge, but rather to helping students at this point. Help is not a specific piece of information, but rather information on where and how to find the right information, either suggesting which book to look for in the visitor center bookshelves or what keywords to use to search the web. The instructor's job is to allow students to discover, fail, retry, debate, and evaluate results.

For high school students who are not really interested in science, the program should focus on the day-to-day application of research results and the processes by which an idea becomes a product. This needs to be demonstrated with the help of credible actors and people with significant experience in this field. A fixed, structured presentation structure should be avoided, the program should be designed to encourage interaction, provide participants with the opportunity to ask questions and develop an open discussion during the program. The main steps in the process of turning an idea into a product are based on models, images, videos and small experiments. The program should focus primarily on key activities necessary to success, and elements of it.

After the visit, students should be asked to complete a questionnaire, but feedback can also be given in the form of an interview. Student feedback should be used to improve the program. After the visit, when students return to their school, or in the days following the visit, teachers need to discuss with students what they saw in the visitor center. This is to ensure that the experience gained at the visitor center is used to the fullest extent possible and becomes part of the students' knowledge and skills.

High school students have the knowledge and autonomy to engage in leisure activities on their own. By organizing these types of activities, research facilities can increase STEM knowledge for students who wish to pursue their studies in science. As a leisure activity, afternoon activities outside the visitor center can be organized for those interested. These activities are led by trainers and use the center's infrastructure during events. During the sessions, similarly to organized visits, students can conduct more complex experiments with the help of instructors. On the other hand, students would be given the opportunity to put their own ideas into practice in the experimental spaces created for this purpose. The necessary infrastructure and support for the students is provided, and the supporting environment is also important. Participants can get to know other schools of similar interest and implementation of joint projects may also take place.

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In addition to the usual activities, special programs are provided for students. The visitor center can organize competitions for students on various research topics at the research facility. Competitions can be held during the school year, when participants can work on different scientific topics. During their small-scale projects, they need access to the visitor center infrastructure to solve various scientific problems. For each participating group, a mentor must be assigned from the visitor center. At the end of the competition, students should have the opportunity to present their ideas to a jury of the research facility staff. As a special program, summer camps can be organized for selected students to engage in activities such as attending lectures, conducting experiments and small-scale projects, and networking with research facility staff and participating fellow students.

6.2.3 Students in higher education

From the perspective of the visitor center of the Research Facility, university students can be divided into three main groups: science students, students participating in teachers training programs, and students with interest in other fields of specialization. As university students have detailed and extensive knowledge, they can not only visit the center but also contribute to its activities.

Undergraduate students in science education should be given the opportunity to take guided tours or, if this is not possible, be given a detailed audiovisual presentation of the research facility. They also have the opportunity to work in teams, but organizing ongoing education programs can be even more effective. In practice, this means that their training-related lessons are conducted by staff at the research facility and are organized on the premises of the visitor center. During the program, they may undertake complex experiments and research and receive credits as a result. On the other hand, university students also have opportunities to carry out their own research and projects. They would need access to the visitor center infrastructure. They can also get in touch with other (even high school) students and share their ideas. Similarly to those for high school students, competitions and summer camps can be organized for college students with topics that suit them. University students may be volunteers or trainees at a research facility or visitor center. They can participate in hosting primary and secondary students, and they can also be mentors for high school projects or competitions.

In addition to the general program, visiting students who participate in teachers trainin programs should focus on the specific STEM teaching methods and principles used at the visitor center. As part of their education, they can contribute to the educational activities of the center. They can participate in the analysis of questionnaires completed by the students after

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the visits and, on the basis of these, participate in the development of methods and programs used in the visitor center. They may also undertake internships, and volunteer to join work and activities related to elementary and secondary school students.

Higher education students with interest in other fields of specialisation may focus on other topics related to the research facility. In addition to a guided tour of the research facility and a visit to the exhibition, they may also participate in workshops supported by the research facility staff focusing on specific areas related to the research activity. Students of participating in buiness related training may attend a workshop on the economic potential of the research facility. Students may also join the visitor center as trainees or part-time employees and gain relevant experience in their area.

6.2.4 Teachers

The role of teachers can be twofold. One is to organize student visits and the other to develop their own professional skills. Not only should they organize the visits taking care of even the logistics aspect of the visit, but they should also inform the visitor center staff about the level of knowledge of the students planning the visit. They would provide students with information prior to the visit, and organise follow-up activities after the visit, thus contributing to the continuous improvement of the visitor center.

In addition to the activities above, high school teachers should encourage talented and interested students to participate in leisure activities organised by the visitor center. They can be the contact points at schools, rewarding students' extra-curricular activities with recognition.

In case of teachers in higher education, mentoring and coordination are important roles related to visitor center activities. In case higher education students decide to join the research institute as a trainee or volunteer, or participate in various competitions and projects, it is teachers in higher education who can support them with mentoring.

6.2.5 General public

In addition to the young and teachers, the third target group is the general public. They are visitors who live in the area around the research facility, in the region or a country, but may also be foreign science tourists who visit the exhibition at the exhibition center but can take part in guided tours. Special events can be organized for this target group, such as open lectures or thematic exhibitions, or events linked to special days associated with the research facility, such as Earth Day or World Water Day.

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7. Experience gained through project activities

7.1 Pilot activities withing the framework of the project

The primary objective of the program organised within the framework of the project was to support young people in their career choices, to raise their awareness of natural sciences and scientific infrastructures that surround them, and to provide an opportunity to assess how to maintain their interest in this field. To this end, pilot visits were organized with the research infrastructures participating in the project.

The Visitor Center of the ELI-Alps Research Center in Szeged was one of the sites visited during the multi-country pilot program. Experimental visits to Szeged were organised mainly for students of grades 7-12, and the program was attended by 404 students. In Austria, pilot visits were organized primarily for 16-18 year old students studying mathematics and physics, as well as university students. In the Czech Republic, 37 respondents completed the feedback questionnaire, 30 of them provided information on gender and age. Of these, 22 were high school students aged 16-17, 16 of whom are studying at science specialisation. The Agroverzum Scientific Adventure Center of Martonvásár also participated in the pilot as a visitor center, where during two visits a total of 50 students participated in the pilot. All of them completed the standard questionnaire at the end of the program, but 48 of them gave a meaningful answer on gender and age. Respondents range in age from 11 to 17 years, with 22 boys and 26 girls.

As a basic concept, interactive, experience-based visits of up to 2 hours were to be organized for visitors within the framework of the pilot. An important aspect of the visits was to familiarize visitors with the operation of an inclusive research center.

As students in public education are immersed in the details of science curricula mostly during their years of secondary education, the main focus of the ELI visits was placed on high school students and the 2 years of their studies before high school. In the majority of pilots targeting students aged 13-18 years, the biggest challenge was to arouse their interest in participation. It is only possible if students are actively involved in the activities during the visits, which ensures their interest on the long run, as well as the knowledge gained during the visit to become long lasting.

Addressing the teachers accompanying student groups was also of great importance. The sensitization of teachers and making them accept the program on the long run is the key to the success of the work started with the pilot visits. In case of visits to the ELI-Alps institution,

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preliminary surveys have already shown increased interest from school principals, whose positive attitude and co-operative approach may determine the long-term attitude of teachers. As the preparation of programs for students depends largely on the teachers, addressing these target groups in particular was of particular importance.

The professional content of the visits was developed with supporting experts from the research center. This is essential, as the professionals employed by the institute are fully equipped with the knowledge needed to design programs that are most interesting to visitors. The visits were composed of the following elements:

1. Brief introductory lecture about the ELI and its activities, and transfer of new knowledge in the field of laser research. During the visits it is of utmost importance for the workers in the institute to communicate clearly and reasonably in order to build a personal nexus between them and the students. The management of programs was in the hands of number of workers, including educators as well, so it was easier to integrate into the everyday life of the Center. Students were also addressed by experts in pedagogy, which made communication so much easier in this rather difficult topic.
2. Introducing the ELI in the Visitor Center section
3. Students were given assignments related to what they have experienced during their visit. The assignents had to be accomplished in groups of 4-5.
4. As a feedback, students and accompanying teachers filled in questionnaires rlated to their visit.

In the various pilots the programs were designed to fit the specificities of the research institute concerned, but in each case feedback was given with the same questionnaire.

At the Szeged site of the pilot activities, 12 schools were involved in the actions. When selecting the institutions, the choice of both primary (8) and secondary schools (4) was taken into consideration. Pilot visits also interated participants studying natural sciences at an advanced level. An important aspect was to equally ensure the participation of schools situated on housing estates, in the downtown or suburban areas.

Public educational institutions participating in the pilot activity (Szeged):

- Dózsa György Primary School of Szeged
- Rókusvárosi II. Primary School of Szeged
- Bonifert Domonkos Primary School of Szeged
- Tömörkény István Secondary Grammar School and Secondary School of Arts of Szeged

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- Tabán Primary School of Szeged
- Tisza-parti Primary School of Szeged
- Deák Ferenc Bilingual High School
- Eötvös József Secondary and Primary School of Szeged
- Radnóti Miklós Secondary Grammar School of Szeged
- Vörösmarty Mihály Primary School of Szeged
- Petőfi Sándor Primary School of Szeged
- Bálint Sándor Member School of Petőfi Sándor Primary School

The visits took place in the last weeks of the school year, at times most compliant with the schedule of education. Visits were organized on school days, scheduled for the morning hours, so it did not negatively affect the students' daily routine. During the selected days, several visits were made in succession. To accomplish this, the transportation of student groups was also organized, taking into account the required time frame.

The main objective of the professional content was to synthesize the knowledge and to integrate the most important information and points of interest into the programs, taking into consideration the group of participants and their background knowledge. The actions were implemented in an interactive way, following the students' needs to the maximum. From a methodological point of view, to ensre interactivity was a key aspect, as well as maintaing students's interest, therefore the program was designed to give participants a taste of science in 15-20 minute timeframes, in groups of 15-20 persons.

A questionnaire was completed at the end of the visits. Through the questionnaire organizers collected information about the experiences, opinions and interests of students visiting the research institution in order to provide the best possible support to the relevant age groups by lessons learnt. In addition to the students' questionnaire, an interview was made with accompanying teachers, which provided an opportunity for their suggestions to be incorporated into the further development of the action.

7.2 Feedback – evaluation of visits

The Visitor Center of the ELI-Alps Research Center in Szeged was one of the sites visited during the multi-country pilot program. Experimental visits to Szeged were organised mainly for students of grades 7-12, and the program was attended by 404 students. In Austria, pilot visits were organized primarily for 16-18 year old students studying mathematics and physics, as well as university students. In the Czech Republic, 37 respondents completed the feedback questionnaire, 30 of them provided information on gender and age. Of these, 22 were high

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The questionnaire consisted of the following questions:

	Strongly not agree	Not agree	Agree	Strongly agree
I enjoyed the exhibition				
I liked participating in an experiment				
I felt that I have enough knowledge to participate in the visit				
I like how the instructor led the workshop				
I feel that I can use what I have learnt in the exhibition at school				
I feel that I can use what I have learnt during the experiment at school				
I would like to attend more visits like this				
I like to read scientific articles.				
I like to watch scientific programmes on te television.				
I like science related films.				
I like scientific games.				
In my free time I usually create or fabricate new stuffs.				
I like maths/biology/chemistry/informatics/physics/geography classes at school.				
I can imagine myself as a scientist in the future.				
The visit affected positively my attitude towards science.				

The answers to the questions for particular program elements lead to the following conclusions:

In the first block of questions (the first 7 questions of the questionnaire), the respondents were asked specifically about the programs and the experiences gained through the visit. Taking into account the data of the three institutions (ELI Szeged, Martonvásár, Institute of Physics), it can be stated that only 12% of the 3435 answers to 7 questions show a negative attitude towards the organized program. Most participants rated the programs positively (87.54%). However, 0.52% (18 responses) of the questionnaire replies were found not to be valid.

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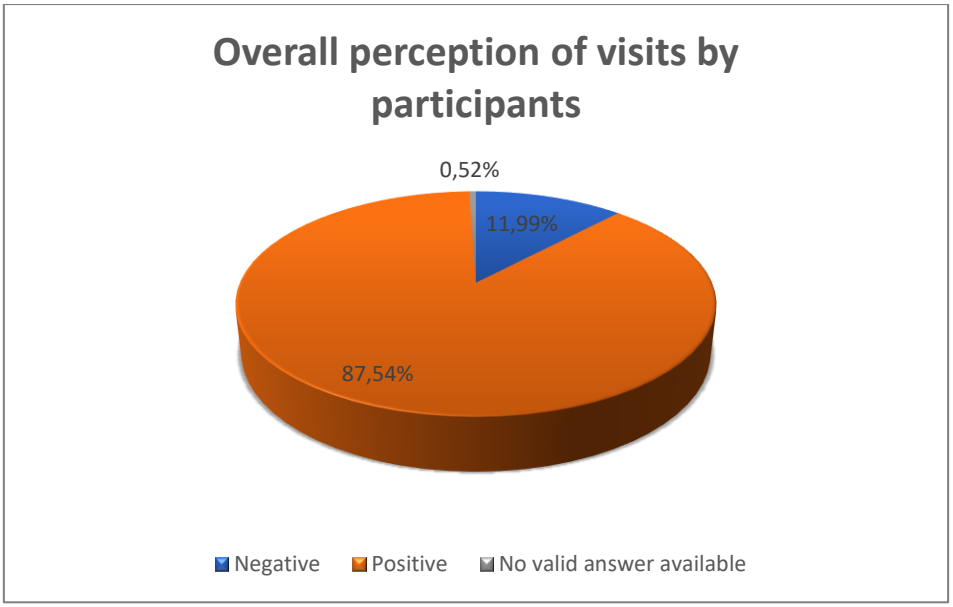

In line with the general trend, similar responses were received for ELI. Of the 2828 answers to 7 questions in the first set of questions, only 9 could not be evaluated. It can be stated that the questions asked were clear and easily understood by the students. Positive responses in this block were 87.3%. On the basis of this, it can be stated that the programs matched the age group, they were interesting, informative and useful.

In Austria, the outcome of the programs proved to be even more positive, with almost exclusively 'agree' and 'strongly agree' answers, while in the Czech Republic 74% of respondents gave a positive answer. In general, programs organised in all three pilots were liked by participants.

When evaluating the question “I enjoyed the exhibition”, it is noteworthy that many of the primary school male students in ELI-Alps tended to choose "I totally agree" option rahter than “I agree”, which is unquestionably enthusiastic. At the same time, a number of paticipants praised the amount of information in the text review section. Others would have liked the presentation to have a faster pace, but in proportion, critical remarks worded related to the visits were only given by a small number of participants.

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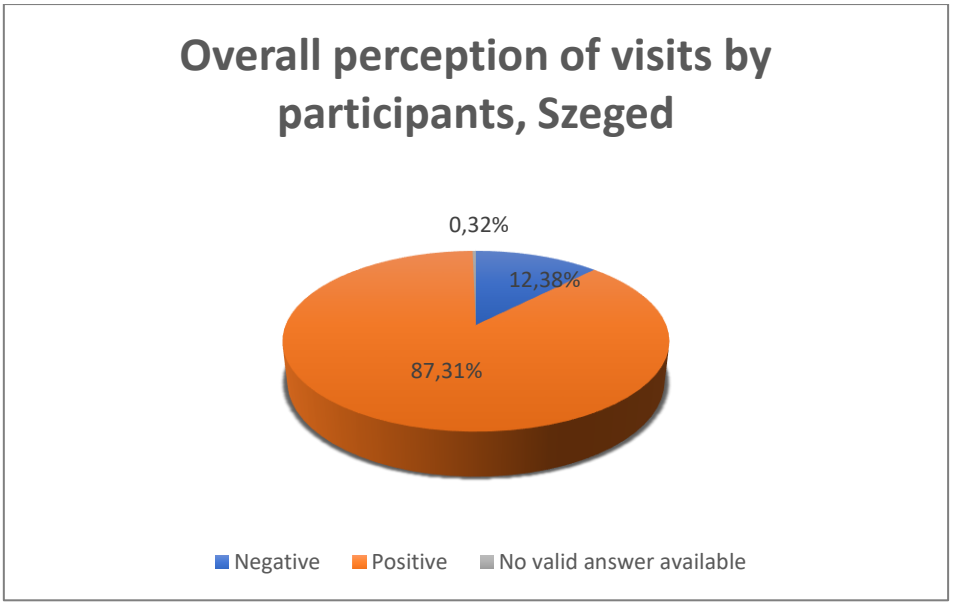

It should be noted that, among Austrian university students, there was little or no written opinion as feedback. Against this background, it is necessary to reconsider whether it is necessary to include rext review sections in the questionnaires for this age group and, if so, what questions to ask.

It is interesting, that the amount of negative opinions about the tour in ELI is equal by count and percentage as the negative reviews about the lecture, 4 percent, which is 10-13 percent in case of the Czech pilot project. From this fact, you can deduce that the impression gained at the beginning of the program is a determining factor throughout the whole event. Regarding the positive and even more positive opinions, boys were more enthusiastic, not only the preschoolers, secondary school students also enjoyed the tour exceptionally. This confirms the general presumption, that currently boys are more interested in physics. This experience can be especially useful, since it helps to further enrich the contents of the program.

It was not an easy question for those who filled out the questionnaire to say whether they thought they had enough knowledge to fully comprehend the visit. In the ELI-Alps, 24 per cent felt that they would rather not, but very few of them indicated a negative option. The feeling is, of course, subjective, and there may be some modesty in the background.

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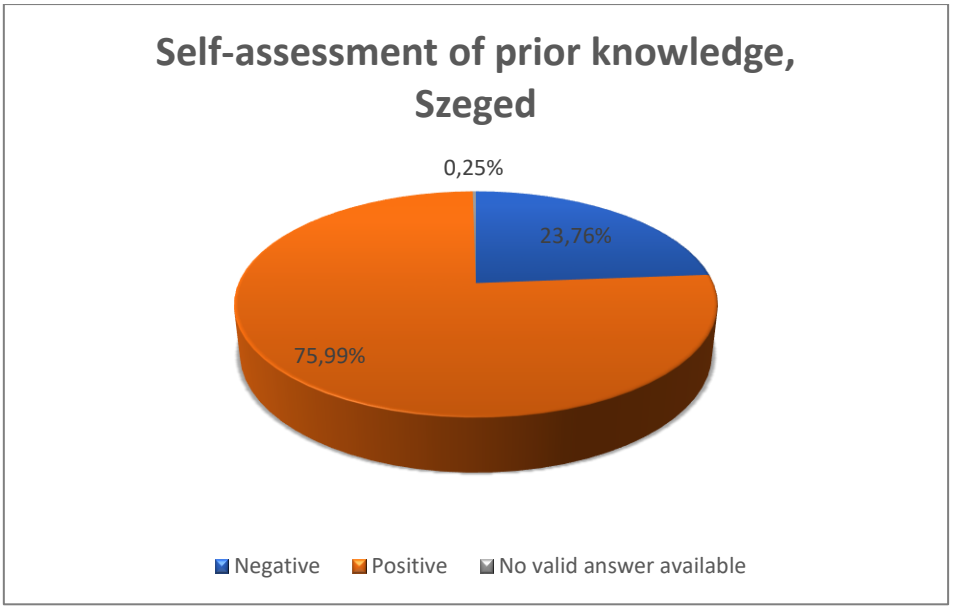
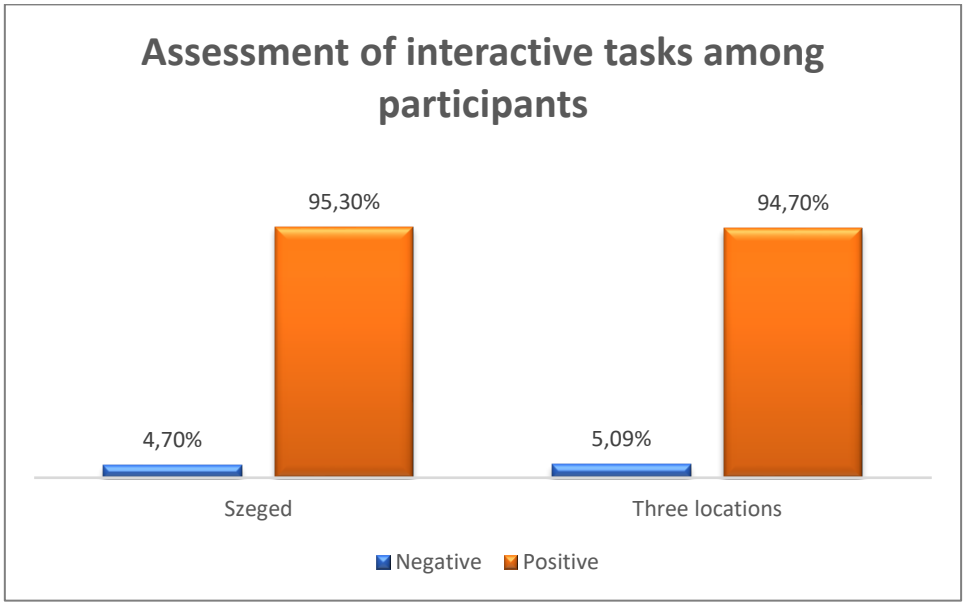


More than 95 percent of the students liked the interactive part of the visit, and the responses seem to show a bit more consistency between the boys: the proportions nicely rhyme with the first question, asking about the exhibition.



When asked if they felt they could use what they saw at school, four out of five students said yes (81.67%), which is a very encouraging feedback. Only slightly worse (78.21%) is the response rate in the positive domain related to the use of interactive tasks at school. In this latter case, the lower rate of positive responses may be due to the necessity of paying special attention to creating a conscious relationship between what is seen and experienced and the school curriculum. If not, solving the task will provide the visitor with significant knowledge, the experience will contribute to the acquisition of long-term knowledge, but the experience itself

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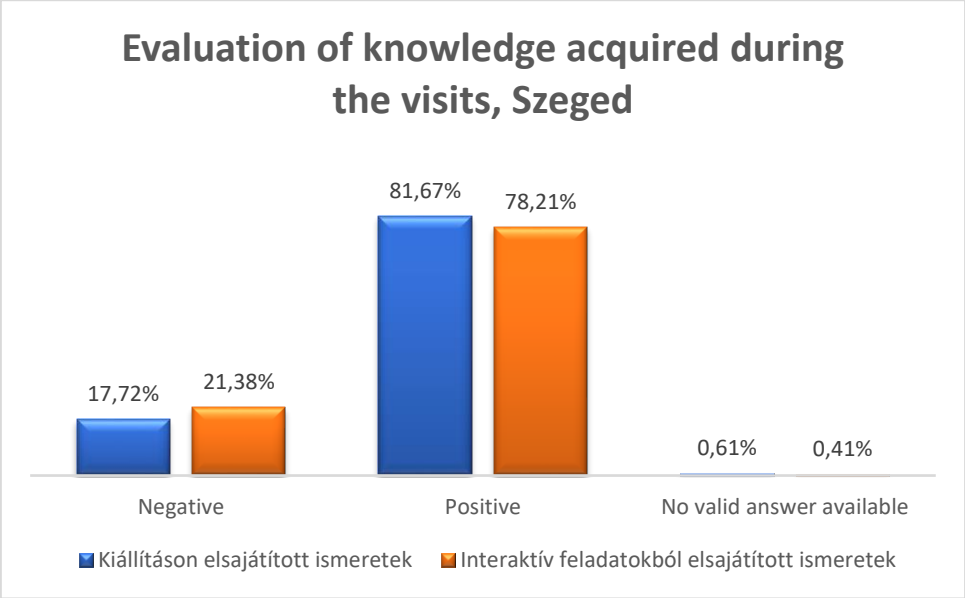
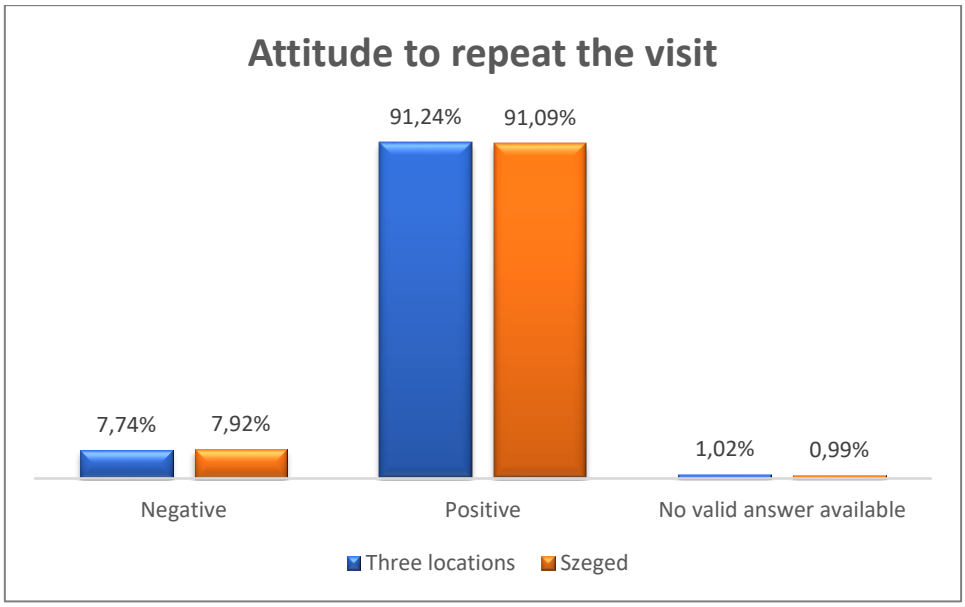
will prevent participants to relate the knowledge gained to school curruculum. Therefore, the role of teachers accompanying visiting students during the follow-up activities is particularly important, as they are the ones who bring the students' attention to the school curriculum points during discussions following the visits.



With an overwhelming 92% majority, students want more visits and tours similar to the pilot program, and they not just simply want it, tey really want it. The ratio is unique to the pilot location in Szeged, and it is almost exactly the same when examining the aggregate data of the three locations.



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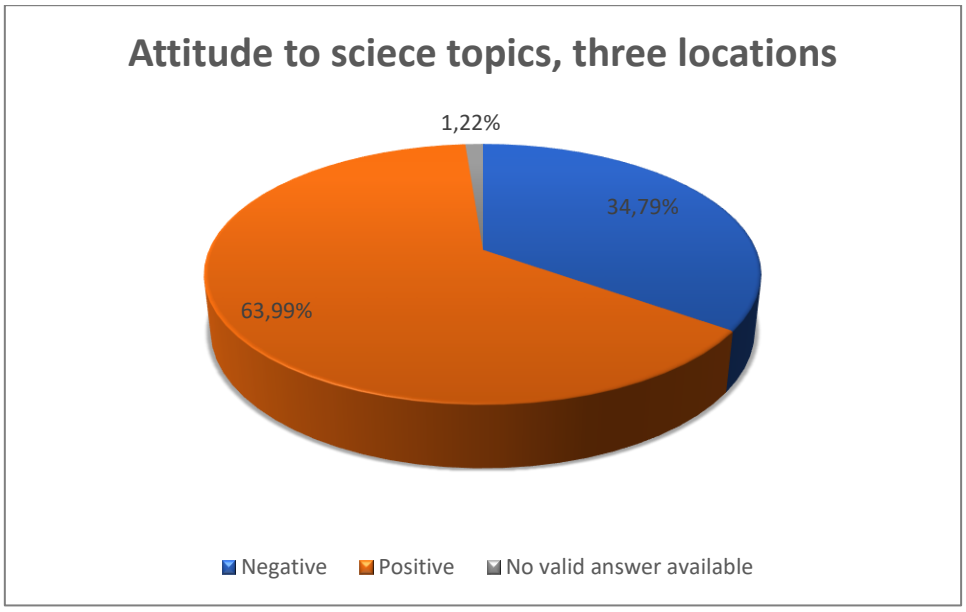
The questions of the second block referred to the interests and future plans of the students. In this case, in ELI-Alps, out of the 3208 responses only 24, that is 0,7% could not be evaluated, thus the conclustion that the questions were well-worded. The 62% of answers with positive content show, that a bit more than the half of the students have plans related to, and interest in natural sciences. Similar proportions can be identified by extending the evaluation of the questionnaires to the three pilot sites (ELI-Szeged, Institute of Physics, Martonvásár). Approximately 61.3% of the participants are positive about science. They have a positive attitude, they actively read science-related readings, articles, or watch films, and enjoy working on science-related projects in their spare time, showing a positive attitude to science subjects even at school.



Interestingly, IT students in Austria did not like science subjects at school, but could imagine their future in science-related fields. This applies to the field of information technology.

However, some 38 percent of participants in the program do not necessarily like to read scientific articles. It also shows that whoever loves this activity, is more likely to give an answer “like it a little bit” rather than “like it a lot”. Watching scientific TV programs received less rejection than reading, for this question, only one student from five marked their answer in the negative range. Today's digital generation is easier to capture with motion pictures. However, an even more favourable picture is gained when the question puts the emphasis on wathing science films: five out of six children give positive feedback on the issue.

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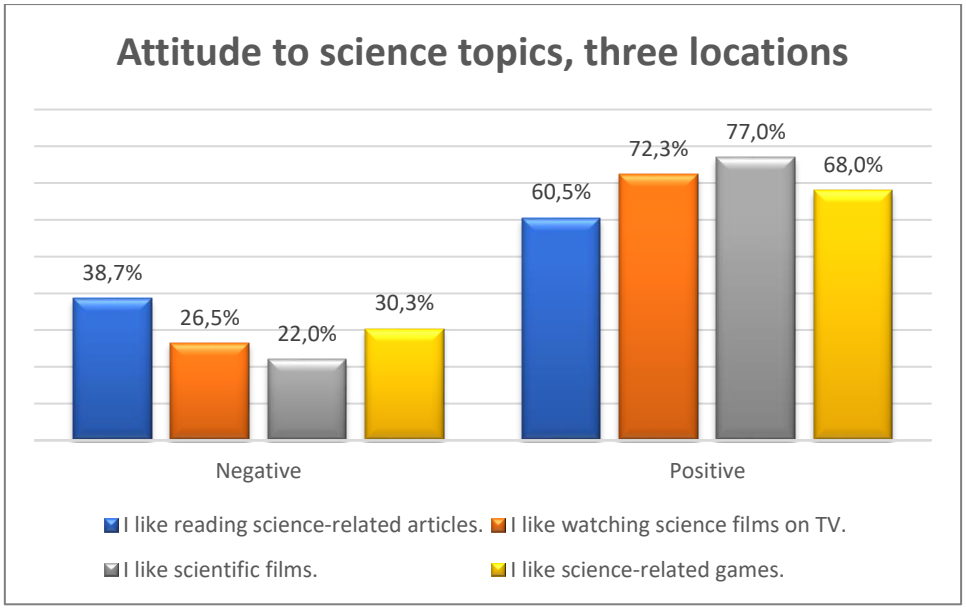

About 30 percent of respondents do not like science-related games at all. This attitude is reinforced by the fact that in their spare time much less than half of the students create or make new things. Seven out of ten love science lessons at school, though it is no use drawing far-reaching conclusions based on that, due to the slightly general wording of the related questionnaire section.

Those 16-17 year-olds from Austria, who study at a physics specialized class, are not only imagining their future in a similar environment, but also have expressed their positive opinion about the whole program. It can be stated, that at this age, they have a more settled view about their career. Their answers are coherent.

In ELI-Alps, only 4 percent of the students had a negative answer. During all the pilots, the students phrased a very low number of negative comments and ratings at the end of the survey. The typical answer was that they found the program a bit short, also they didn't have enough time to get to know the laboratories, this was especially highlighted during the Hungarian and Czech pilot programs.

Of the 37 students participating in the Czech program, they asked what they liked best 20-20 students chose the VR goggle program and participation in the experiment, again highlighting the importance of interactivity.

Some students found the information a bit too much at once; others felt like the presentation was slow and languid. Some of them made up a smart negative quip, for instance, they pointed out as negativity, that it was not possible to shoot with the laser. In addition, the briefest opinion

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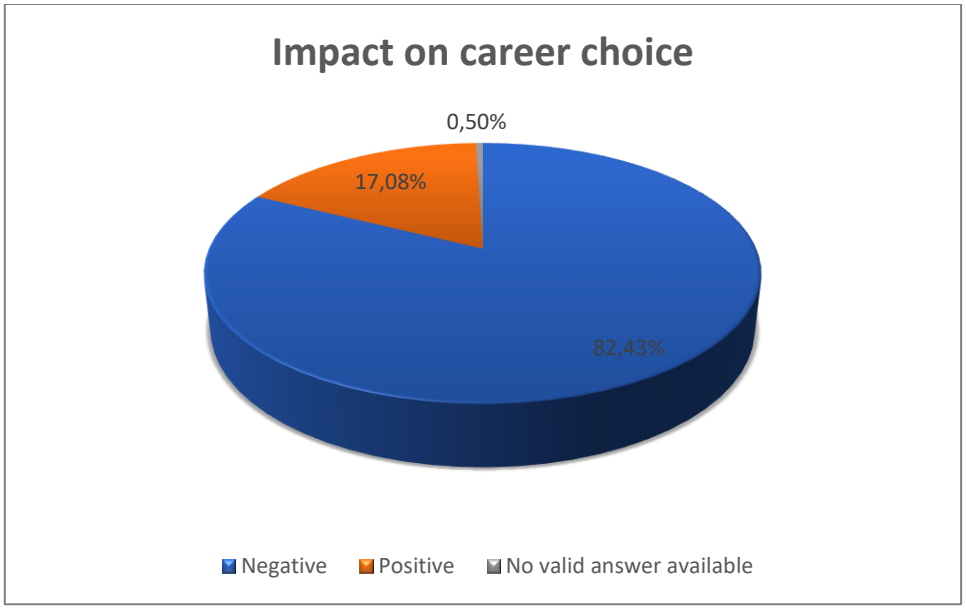
was, that it was too short, most of them wrote that, just as, many of them wanted to enter other laboratories and every building, and they would have enjoyed checking the laser too.

A single visit to a laser center is not expected to make every child immediately imagine their future as a researcher, as 83 percent of the answers indicate it, but nearly twenty out of four hundred respondents have a rather definite idea concerning their possible carreer choices. The good news is that the vast majority of visitors have changed their attitude to science in a positive way.



Based on the above, a greater proportion of participating students found the program interesting and useful than many who had already shown interest in it. The visits also attracted the interest of students who had not previously been interested in science-related fields.

Based on the facts mentioned above, the majority of the students found the program useful, more than those who had arrived with an already given scientific orientation. A pattern can be seen in the Austrian and the Hungarian pilot project in the given answers, that is, the specialization of the interviewee at school is a determining factor. Most of those who already study at scientific specialization imagine their future in the research field. This already assigns their career choices and their future plans. This is only alters only in few cases. Also, it is visible, that a single program, that has been rated useful, is not enough to make a change on the long run. Austrian university students, of course, arrived with an already established orientation, which also determined their answers. Text reviews were mostly missing from their

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part that is why it might be necessary to take into consideration whether it is needed to ask such questions of them.

7.3 Teacher interviews

At ech occasion, teacher questionnaires are completed, when acconpanying teachers are asked to answer the following questions:

- Do you think students enjoyed the program at the visitor center?
- Do you think a visit can help improve school performance, especially in mathematics, physics, chemistry?
- Would you use some of the methods you saw during the visit at school? If so, why?
- How could the visitor center be improved center to make a better impact on education?
- What is your area of expertise?
- How old are the students in your group?

In addition to teachers specializing in other fields of science, mathematics and physics teachers also participated in the interview. In all cases, the first question was answered "yes", which complied with the answers students gave for their similar question. The second question was also answered in the affirmative, with the addition that a one-time opportunity should be made regular, which could better support the work of teachers at school.

For the fourth question, educators anwers confirmed that they want a program more interactive, which also echoed with the feedack students had given.

The comparison of the pilots proves that the survey was credible because similar, almost identical results were obtained with only slight alterations. The overwhelmingly positive answer to the question of whether students would be interested in participating in a similar program, is certainly due to the fact that the programs have moved from the school to a new environment.

Summarizing the views of students and teachers, students were more positive about the programs than teachers. It is recommended to engage professional theachers a group of experts when further development of the programs take place, for they have up-to-date information on everyday educational content and opportunities and can work together on how the visitor center canbest complement formal education, expanding and improving the effectiveness of their work.

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In all three pilots, the importance of interactivity and the demonstration of experimentation and virtual reality, both as a demand and as an experience to be gained, was acknowledged by both students and teachers.

8. Summary, lessons to learn

Today, the role and importance of science centers is gradually increasing, not only because of their role in science, but also because of their impact on their wider environment and society.

Science centers contribute to a better understanding of scientific issues and to deepening the scientific knowledge of the general public. Through interactive programs, visitors gain lasting memories and knowledge during their visit, and as a short-term result, their motivation and interest in scientific issues can be identified. Visiting centers of science research centers often engage their visitors with interactive activities, which contributes to increasing students' scientific knowledge, regardless of school performance, which is true for all age groups. Among their positive effects the new attitude that students develop as a result of a visit can also be mentioned. Visits to science centers in all age groups of students positively influence motivation and influence children in their career choices.

All these positive effects can also be demonstrated through pilot visits organized within the framework of the project. The visits were carried out in collaboration between four project partners, covering a wide range of target groups, including primary and secondary school students and higher education students. The target group also included teachers to accompany students, who play an important role in organizing the visits and prepare students for the event beforehand, and their role is also crucial in interpreting what they have seen and experienced in the course of the visits and to establish links with the curriculum.

In terms of program design, it begins practically with a pre-visit preparatory phase, in order to provide students with the basic knowledge necessary to facilitate a better knowledge transfer during the visit. After arriving at the facility, visitors will first be introduced to the research infrastructure through an audio-visual tour, and then, if possible, guided tours of the facility will take place. The visit then continues with the interactive exhibition and the realization of specific scientific experiments.

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For primary school students, the purpose of the visit is primarily to show that science can be fun and interesting. The content of the visits needs to be defined accordingly, with due emphasis on integrating interactive activities to capture the attention of the age group. High school students can participate in programs similar to primary school students, except that the scientific content presented to them and the related interactive activities must naturally adapt to their own background knowledge. As a special opportunity, a range of competitions organized by the visitor center on different research topics of the research facility during the school year is also a special option. In the case of university students specializing in STEM studies, classes related to the special field of recearsh of the facility can be integrated in their training program with the assistance of the research facility staff. They can participate in the educational activities of the center and contribute to the visits of primary and secondary school age groups through professional practice and volunteering. Visitor centers also target the general public, for this purpose special events such as open lectures or thematic exhibitionscan be organized as well as events events that can be associated with the research field of the facility.

From a methodological point of view, keeping the attention of the participants during the visits is also important; for this purpose, the program is practically designed in such a way that participants get a taste of the science world in 15-20 minute sections and in groups of 15-20 persons.

At the end of the visits, the possibility of feedback is of utmost importance, with the help of a specially designed questionnaire, since the information obtained in this way greatly helps the visitor center in optimizing the activities and the framework of organized programs.

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