

INFN ScienzaPerTutti: 20 years of science for society

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A groundbreaking and ambitious project took shape within the Istituto Nazionale di Fisica Nucleare (INFN) community 20 years ago. The driving aim was the intent to popularize physics, and all this started through a web portal. Since then, the general public and, in particular, students and teachers have been engaged with cutting edge topics of modern research in particle and nuclear physics, astroparticle, theoretical and applied physics. During the 20 years from its birth, the *ScienzaPerTutti* project evolved in many different directions, becoming a reference point in the Italian landscape, with an average of 3000 contacts every day on the web pages and thousands of followers on the facebook profile. The project encompasses a variety of multimedia products like didactic units, research materials, infographics, interviews, book reviews, and, more recently, podcasts. A particular feature of many of these activities is a constant call to action to directly involve the audience, providing a continuous challenge for the *ScienzaPerTutti* editorial board to improve contents and devise new approaches. This contribution focuses on some of these activities, even if it does not provide an exhaustive description of all the programmes and opportunities that are offered to our public for lack of space. Finally, we provide an outlook on new activities.

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1. The “ScienzaPerTutti” project

In 2002, some INFN researchers had the idea and the resourcefulness of creating a web portal to reach a wide public with the aim of raising and increasing, where already existing, the interest in science, addressing in particular topics in modern physics. In this way the *ScienzaPerTutti* [1] project was born. At that age, the internet was not as widely available as it is nowadays, and the project was a challenging choice, a strategy that, with hindsight, has proved to be successful. In these 20 years the project has significantly evolved, extending the variety of initiatives offered to the public, and involving in the editorial board not only researchers, but also people expert in communication of science. The graphic of the banner in the web site, with the menu (in Italian), is shown in Fig. 1.



Figure 1: Banner of the *ScienzaPerTutti* [1] web page with the main menu (including the “Ask to the expert”, the context sections).

The project has gradually established a direct and effective interaction with the general public through many channels, proposals and initiatives. Moreover, *ScienzaPerTutti* has been addressing students and teachers from middle- and high-schools, providing in-depth material about scientific topics, offering interesting insights about cutting edge topics in research, and involving classes in yearly contests of scientific content. The project developed substantially during these years, always trying to keep pace with the evolution of the communication media, and maintaining a high level of interest in the public even with the increasing offer of scientific contents on websites and social media.

When it comes to the numbers, even though we always look for more articulate feedback than just numbers, *ScienzaPerTutti* currently counts more than 2000 subscribers to the monthly newsletter, more than 7000 followers on our facebook profile. We had more than 800.000 visits to the web page [1] in 2021, with around 2500 visitors on average per day.

2. Interaction with the public

During these two decades *ScienzaPerTutti* has particularly searched for a direct contact with the public, both answering the questions raised by them, and with monthly quizzes where they had to answer, as well as presenting activities at the most known scientific festivals and fairs around Italy. Such an approach requires dedicating resources and time to all the planned activities, but it

pays back with direct feedback, a crucial way to get a response about the degree of appreciation and to understand if and what can be adjusted or improved.

A quiz about past discoveries or more recent challenges in physics has been published monthly on Facebook since 2015. Participants have to choose among a few possible answers, providing a short motivation for the chosen answer and the fastest two that answer correctly win some gadgets. An example of gadget is a water bottle with a question printed on it: "How many atoms of water are inside this bottle when it is filled?" and a QR code linking to a web page on our site where a detailed answer and the needed calculations are provided. The public has demonstrated to appreciate the quiz by promptly answering every month.

Answers to questions raised by the public are handled in the "Ask the expert" section. We receive tens of questions each month, the most interesting and intriguing ones are publicly answered on a dedicated section in the website. The answers are prepared by experts in the relevant field, chosen among colleagues from INFN or Universities across Italy, and are labeled with a color (green, yellow or red) according to the degree of difficulty of the topic and of the answer (easy, intermediate, hard, respectively). A broad variety of topics is covered by this Q&A section, ranging from astrophysics and space science to quantum mechanics, and the standard model. Therefore one can find answers to very different questions, ranging from "Would it be possible to artificially create gravity on the International Space Station to avoid osteoporosis for astronauts?" to "Where does the Higgs boson disappear after it is created?".

In 2018 and 2019 we participated in the Genova "*Festival della Scienza*" [2], a scientific fair held annually in Genova, where the proposed activities have to pass a selection process through a scientific committee. At this festival, which lasts two weeks, we set up a stand where the public was involved in a challenging scientific quiz that was triggering interesting discussions on dark matter, particles and accelerators, applications of interest in everyday life and in medicine. We had the opportunity to meet hundreds of people and arouse their interest and curiosity about scientific research.

3. Initiatives dedicated to schools

The interaction with students and teachers from Italian middle- and high-schools has been very fruitful since the beginning of our project. The contest we yearly open for schools has reached its eighteenth edition. This is usually organized in three sections: for middle-school students, for the first two years and for the last three years of high-school students. In year 2021 the contest was about finding scientific errors in movies, songs, art and literature and the competition foresaw three steps, as the students, organized in groups of 4/5, had to prepare a written essay, a meme and finally produce a video explaining the error they found and explaining why it was an error. More than 350 students participated, 16 teams were awarded in total and could participate in a hands-on activity at the INFN laboratories in Frascati, visiting the facility and the experiments, and having the opportunity to meet and talk to INFN researchers. In the 2022 edition, students had to announce and concisely explain a scientific discovery to the world, contextualizing the announcement to the period in which it was done. The submitted videos spanned from the measurement of the atmospheric pressure done by Torricelli to the discovery of the cosmic microwave background, passing by general relativity. The aim of the contest is to have students enjoy physics, even modern

topics, not yet included in school programmes, such as dark matter or quantum physics, letting them find a key to explain the subjects in a simple but intriguing way. It is never easy to judge the received material and assign the awards, since the quality of the contents and the degree of commitment shown by their works is in most cases extremely good.



Figure 2: Banner of the 2022 context for schools “Eureka! Chronicle of a discovery”.

During these years the *ScienzaPerTutti* editorial board prepared several educational “packages” for students, covering different topics. During the pandemic, and in particular during the lock-down, when students were forced to follow lessons from home, new topics were added, the material was revisited, expanded and updated to the most recent development. The 42 packages were organized under 8 macro-areas (fundamental particles, relativity, gravitational waves, cosmology, cosmic rays, particle accelerators, gravity, and quantum mechanics) in a new section named "At school with you". The initiative was highly appreciated by teachers and students, and the material has been looked at as a reference point in particular by high-school students, some of whom asked permission to include some of the material (figures, infographics) in their work for the final exam. Another largely appreciated interaction with the students is the showcase that we give on our website to their works triggered either by our educational materials or by seminars and lessons delivered by INFN researchers in their schools. They have a dedicated page, named "Done by you", where we publish the most relevant, original and inspiring works. Here one can find a picture of the atomic model realized by a middle-school class, as well as a podcast in English speculating about different atoms and the possibility of life on other planets, or a short essay about the Higgs field.

We also want to be present in schools and, for this purpose, we designed two posters in 2017 and a calendar in 2021. In both cases schools could request free copies through our website and we sent more than 1000 copies, even to a school in Argentina. The two posters were about the

standard model and the gravitational waves, while the calendar was giving a short insight into the life and discoveries of 6 male and 6 female physicists, one per month. A teacher from an Italian middle-school, at the end of the year, wrote to us that she had the opportunity not only to talk about those scientists, but also to introduce topics that were unknown to students and, moreover, to motivate and encourage young girls in pursuing scientific studies in their future.

4. An exhibition dedicated to scientists and scientific challenges

The calendar for the schools was realized with the contribution of an illustrator, Francesco Fidani, that drew an artistic portrait for each of the 12 scientists: Fermi, Goeppert, Hamilton, Hofstadter, Hubble, Meitner, Oppenheimer, Payne, Rabi, Rubin, Wu, Zwicky. This project inspired the design of an exhibition exploiting these drawings, together with the narration of the lives and the challenges faced by those scientists both as human beings and as people making science during the last century. In this way, talking about Edwin Hubble and his skills in basketball, allows one to talk about his revolutionary discovery that the Universe was not only far larger than the Milky Way, but also that it was expanding and not static as it was believed till then. On the other hand, by telling the story and the achievements of Vera Rubin, one has the opportunity to explain the discovery of dark matter and how it still constitutes a challenge in modern physics. Narrating Rabi's life and research, the link between physics and medical fallout is provided by the discovery of the magnetic nuclear resonance and its application as a diagnosis tool. The scientists included in the 4 stations of the exhibitions were: Enrico Fermi, Lise Meitner, Cecilia Payne, Robert Oppenheimer, Chieng Shien Wu, Robert Hoffstadter, Edwin Hubble, Vera Rubin and Isaac Rabi. The exhibition was designed in collaboration with the ISIA Design Institute of Rome and it was inaugurated at the "Festival della Scienza" in Rome [3] in November 2021. Even though the pandemic restrictions were still in place, the exhibit was visited by more than 400 students from high-schools and 300 "standard" visitors of the fair. Schools were guided through the exhibition by members of the *ScienzaPerTutti* editorial board or by our INFN colleagues, while the general public could either join a guided tour or go through the installation on their own. Before the guided tour, we asked the visitors to answer if and whom, among the scientists, they already heard about or knew, and it turned out that the majority (more than 36% of the total) already knew, as expected, Enrico Fermi. After the tour, they had to express their favorite scientist, and Edwin Hubble with his Copernican revolution of our knowledge about the universe was the one by far leading the chart.

5. Outlook for the future

Encouraged by the quite positive feedback we are constantly receiving, but also trying to learn how to innovate our portfolio and possibly reach new people, we are currently embarking on new adventures. The first one, that has just been launched, is an app to play with physics from a smartphone or a tablet [4]. The app has been devised by the *ScienzaPerTutti* editorial board, then its executive development has been outsourced to a specialized company. The game develops through multiple choice questions, divided in three groups, according to their degree of difficulty, and are about astrophysics, particles, history of physics and "unexpected physics". The aim is to engage mainly young people, but not only, to play with physics and to challenge their friends. Very recently,



Figure 3: Banner of the exhibition for the Rome “Festival della Scienza” 2021, with the artistic drawings of Enrico Fermi and Lise Meitner, made by Francesco Fidani.

we also created an instagram profile under the name “ScienzaPerTutti”, in order to try to involve daily the youngest public, and to give them an insight into modern research that goes beyond what they learn at school during the science or physics lessons and, hopefully, to inspire them to pursue a career in physics or simply to nurture their interest in scientific topics. We will continue to provide accurate information about research in physics in an appealing way, continuing to be a source of inspiration for young (and less young) people for a long while more.

References

- [1] *ScienzaPerTutti* web site <http://scienzapertutti.infn.it/>
- [2] *Festival della Scienza di Genova* <https://www.festivalscienza.it/site/home.html>
- [3] *Festival delle Scienze di Roma* <https://www.auditorium.com/festivaldelle scienze/>
- [4] *ScienzaPerTutti: an app to play* <https://bangsxt.infn.it/game/>