PROCEEDINGS OF SCIENCE

Engaging children with science, the INFN Kids project

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INFN Kids is a science education project of the Italian National Institute for Nuclear Physics addressed to young people of Primary and Middle schools age. The initiative aims at raising children's curiosity towards science with a focus on Physics, inspiring them with science by illustrating the different research fields that INFN is pursuing, the development in technologies along with the applications in everyday life and presenting people who animate science. It gathers technicians and researchers of thirteen units and National labs in the design and realization of multimedia products, laboratory-based activities, comics, science demos and exhibits. The activities are conducted online and in person in schools, science festivals and at INFN's sites. The adopted methodologies and the didactic tools (lectures, interactive lessons, hands-on sessions, science games) involve children in the direct exploration of natural phenomena. Given the manifold plan of activities the recipients of the project are also teachers and families, and this allowed to expand and use different formats to meet the audience's requests. We here present an overview of the ongoing initiatives to share our experiences and we illustrate in particular the comics centered on the characters Leo and Alice that drive children in the investigation of the micro and macro world, and the laboratory-based activities designed to introduce kids some fundamental concepts related to matter and its inner structure.

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1. The INFN Kids project

As suggested by the name, INFN Kids [1] is a Physics education project targeted at children between the ages of 6 and 13. Created in 2020, the project developed with the main purpose to gather and share experiences, models and best practises gained from various units of the Italian National Institute for Nuclear Physics [2–4] in public outreach initiatives that involve children in exploring Physics phenomena and raise awareness about the importance and benefits of research results in our daily lives. While the primary target audience is represented by children, the wide variety of activities reaches out to teachers and families as well. The team is composed by more than 70 INFN people from 13 units. The objectives of the project include sharing scientific knowledge such as discoveries, facts, and information about scientists' lives, as well as introducing INFN research experiments, facilities, and technologies, and their impact on society. It aims to inspire and motivate young people to pursue science, explore the connections between Physics and other disciplines, and engage children in the learning process through storytelling and interactive science activities. Moreover, it seeks to enhance the cultural role of the scientific method and foster bonds and collaborations with various entities in the local community, including schools, social and cultural associations, libraries, research centers, and universities. In the following section the educational program is presented with a focus on the main activities that are carried out both online (INFN Kids YouTube channel) and in person (either inside or outside INFN sites)

2. Educational program

The topics treated in the educational products encompass classical and modern Physics like light, sound, heat, forces, pressure, electricity and magnetism, matter, particle physics, Solar System and space-time, and cosmology. Contents and methodologies are tailored to different target audience ages, taking into consideration the context and the type event. The educational resources and initiatives are designed to enhance visual, auditory and kinesthetic learning. The plan of activities is developed across four main ares:

- **Science tales** that include videos and podcasts dedicated to the life female and male scientists of the past and the present, as well as their discoveries;
- **Laboratory-based activities** that feature didactic units structured in interactive lectures, hands-on and science demonstrations to explore Physics phenonema through direct observation;
- **Guided tour to INFN sites**, organized in visits to research facilities and labs to present INFN experiments and meeting with researchers;
- **Science games and comics** conceived as playful learning-based products to introduce physics issues in informal context;

As an example of the *Science Tales* section, we here mention the video devoted to Galileo Galilei, in which a researcher/actor played the role of the famous Italian physicist talking about his live and presenting his discoveries. To enrich the narration with a demonstration, the colleagues

Figure 1: *From the left, Simone Valdrè playing Galileo and on the right, a frame taken from the free fall in vacuum experiment performed at INFN LNGS.*

from INFN Gran Sasso National Laboratory performed the experiment of the free fall of objects in vacuum, see fig. 1. The video is part of an INFN Kids YouTube channel playlist including Vera Rubin, Archimedes and Ada Lovelace stories [5].

The *Laboratory-based activities* are conceived to engage children either in science demonstrations, in the realization of hands-on experiments or in the production of science-related creative crafts. These activities include interactive lectures carried out in schools or science festivals, and video tutorials posted on the INFN kids YouTube channel. The lectures are structured in didactic paths tailored to the age of children, and are meant to explore a Physics topic through a sequence of experiments performed using low-tech and high-tech materials. The main idea is to investigate the Physics around us and its applications in daily life. As an example of lecture, we here briefly report about the didactic path devoted to electricity. In this framework we want to study the phenomena related to charging. After an introduction to atoms and their constituents using models and animations, we focus on electrons, their charge and the Coulomb's law. Using easily available tools like balloons, cans and pieces of paper we highlight with children the difference between insulators and conductors. A series of experiments are then performed directly by pupils to test charging by friction and induction. Among these, students are asked to build an electroscope by means of a glass jar, a styrofoam plug, a paper clip and aluminum strips, and have to fill a simple concept map based on images to explain how it works. Charging by conduction is usually introduced using a portable electrostatic generator that makes small strips levitate. Using a Van de Graaff exhibit we perform several experiences to explore in depth this kind of charging. Finally, in order to revise the concepts, we propose a crossword puzzle as a playful interactive closing session that serves also as a feedback. The science-related crafts are usually the core activities of the summer and winter online camps we broadcast on YouTube. For instance during Winter 2022, a series of videos for the Advent Calendar in which researchers explain how to create science-themed Christmas decorations were posted. These decorations were devoted to the INFN Kids cartoons of particles. While showing the procedure to prepare the decorations, researchers presented the main characteristics of protons, neutrons, electrons, and photons (see fig. 2).

Another pillar of the INFN Kids project is represented by the *Comics*, designed and realized by INFN researchers, whose protagonists are two children Leo and Alice. Leo and Alice have a deep passion for science, technological challenges and adventures. The comics are organized in episodes

Figure 2: *From the left, the YouTube banner of the playlist dedicated to the Advent Calendar 2022, in the middle the making of a photon-themed Christmas decoration and on the right the final result.*

in which ordinary and familiar situations take an imaginative twist when Leo and Alice encounter particles from the Standard Model and unravel the mysteries of various physical processes. The comics can be downloaded for free from the website of the project [6]. In each episode quizzes and games are presented to engage and entertain children in reading. The collection is available also in a black and white version as a coloring book. In the episode "The story of a glass of water" Leo and Alice explore the microcosm of molecules, atoms and quarks starting from the water contained in a glass. In "A photonic adventure" our mascots meet the photon and together they investigate cosmic rays. "Leo, Alice and the unexpected X ray event" is devoted to X rays and it is explained how a radiography works. This episode realized in collaboration with Hamamatsu Italia is also available in Japanese and English. "A volcanic expedition" is dedicated to volcanos and natural radioactivity. These educational products allowed us to expand our reachability as, thanks to these comics, we

Figure 3: *The cover of the four episodes of Leo and Alice comics.*

were able to take part to national comics festivals like Lucca Comics and Etna Comics where we presented our project and activities.

3. Conclusion

INFN Kids is an educational and popular science project in the field of Physics that is designed for students in Primary and Middle School, aged 6 to 13 years old. The project aims to inform and engage children through the use of storytelling, experiments, and interactive learning activities. These initiatives provide children with insights into Physics discoveries, experiments, scientists, technologies, and their everyday applications. The activities are developed by the staff of 13 INFN

Units and National Labs, and they are conducted both in-person and online, occurring both within and outside of INFN sites. Over the past year, more than 2000 children have participated in hands-on experimental sessions and guided tours. In addition to these activities, public outreach events have been organized as part of science festivals, European Researchers' Night, cultural events, and open days, allowing for further expansion of the project's audience. The future plans for INFN Kids include the development of new educational resources and didactic units, the creation of comics, science exhibits, and games. There are also intentions to enhance the accessibility of the educational resources. Collaborations are being sought with other research centers, universities, and partners and we foresee to conduct a detailed study on the impact of these activities.

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