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Raise your hand if you've ever met face to face with a Cartesian diver, built and operated a ball accelerator, or successfully popped a balloon inside another, leaving the latter intact...

The **HOP "Hands-On Physics"** project (www.hopscuola.it) was designed to bring to the classroom these experiences, and to help junior secondary school students from all over Italy come up with their own scientific questions to understand different underlying phenomena.

With the goal of innovating didactics regarding STEM subjects, HOP is ideated, developed and promoted by CERN (European Laboratory for Particle Physics) in Geneva, Fondazione Agnelli and INFN (Istituto Nazionale di Fisica Nucleare, or National Institute for Nuclear Physics) with financial support from Intesa San Paolo and Stellantis Foundation, the charitable arm of Stellantis.

Providing an experimental kit and specific teacher training courses, starting in November nationwide, the initiative aims to promote – in as many Italian junior secondary schools as possible – an early learning of the scientific method, for sciences and physics in particular. In addition, HOP focuses on the advancements of contemporary physics and its challenges, which CERN and INFN tackle with undisputed excellence.

Participation will be completely free for teachers, schools and families.

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HOP is inspired by the inquiry-based learning approach, leveraging practical activities and experiments that can be tried first-hand in class, with no need for a full-fledged laboratory, to help young participants learn through hands-on experiences – just like professionals working in the field of scientific research.

The project is based on two pillars: an experimental didactic kit developed at CERN and dedicated training for maths, science and technology teachers, showing them how to use the kit in the most effective way with their classes.

The **experimental didactic kit** – which will be gifted to the teachers and schools joining the project – consists of a large modular box containing all the materials needed to carry out a series of simple experiments in the classroom, focusing on four subjects in the junior secondary school science curriculum: the scientific method, pressure, light, and electric charge.

The first phase of the **teacher training** will take place in November and December, engaging some 700 teachers in 16 INFN offices all around Italy (in Turin, Milan and University of Milano-Bicocca, Laboratori Nazionali di Legnaro in Padua, Trento, Trieste, Genoa, Bologna, Ferrara, Florence, GGI – Galileo Galilei Institute, Laboratori Nazionali in Frascati (Rome), Laboratori Nazionali del Gran Sasso (L'Aquila), Naples, Bari, Lecce, Laboratori Nazionali del Sud in Catania, and Cagliari). The courses will continue also in 2024 and 2025, with the goal of training approximately 2,000 teachers in total.

Training will be provided in-person during one-day sessions, during which participating teachers will experience first-hand what they can do with students thanks to the HOP kit, stimulating curiosity with an active, engaging and fun method. It will be an opportunity for them to find out more about the research carried out at CERN and INFN and to explore its connections with what they teach in schools. They will meet researchers who actively work in the field of physics and in teaching physics and science, joining a network that may prove useful for their professional development as well. Teachers taking part in the training will receive a certificate of attendance as well as the training credits attributed by the Italian MIM (Ministry of Education and Merit) through the SOFIA portal.

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Each of the four didactic units included in the kit contains a number of activities designed to introduce the key concepts required to understand a topic. The first didactic unit ("The Mystery Box") allows the class to familiarise with the scientific method. The second one ("Pressure") explores the concepts of density, pressure and vacuum, and floating. The third one ("Light") focuses on the main properties of light, its composition, the concept of colour as photon energy and the light-matter interaction. Last but not least, HOP's fourth unit tackles the concept of Electric charge, the interaction between charges and the key properties of electrostatic energy.

"Nothing is more thrilling than learning something new every day," stated **Fabiola Gianotti**, Director-general of CERN. *"The HOP project offers students an extraordinary opportunity to learn physics in a simple, fun and fascinating way, applying the same method scientists use for research. Sharing the beauty and usefulness of science with students and people of all ages is also the main mission we pursue with Science Gateway, CERN's new hub for scientific education, created with the support of Stellantis Foundation. We are proud of our collaboration with Fondazione Agnelli and INFN for HOP, and we hope to extend this initiative to CERN's other member states as well."*

*"We are all well aware – **Andrea Gavosto**, Director of Fondazione Agnelli, commented – of the difficulties and challenges Italian students often face in learning maths and science. It is not by chance that the NRRP itself highlights and allocates resources to improve the quality of STEM teaching, while the Ministry of Education and Merit has recently released new guidelines for the teaching of STEM subjects. International research and our own experience suggest that a more direct approach that is open to exploration – starting from inquiry and experiments to gradually focus on concepts and scientific theories – can help students learn, pique their interest and dissipate the anxiety often generated by studying scientific subjects. The HOP project, with its experimental kit and teacher training, takes a step precisely in this direction. Moreover, at Fondazione Agnelli we are convinced that this way of teaching and learning must become familiar to all students sooner, rather than later. That's why we have decided to focus on junior secondary schools."*

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“We firmly believe in the HOP project, which stems from strong teamwork between CERN, Fondazione Agnelli and INFN. The future of our society is in the hands of our boys and girls: it is our duty and responsibility to provide them with the intellectual tools they need to become critical, aware and independent citizens,” noted **Antonio Zoccoli**, President of INFN. *“The most powerful approach we have to gain knowledge, as well as to face problems and great challenges, is driven by the scientific method: an extremely effective tool not only in the field of science, but also when applied to everyday life. With HOP, we hope to have put together a small but effective ‘toolbox’ that may support teachers in the crucial work they do for the education of new generations.”*

HOP stems from CERN's broader project for the new Science Gateway in Geneva, located near its laboratories and the Large Hadron Collider (LHC). The centre will be an important hub for the popularisation of science and, in particular, of particle physics. CERN's Science Gateway, with the building designed by Renzo Piano, will inaugurate on 7 October and is expected to welcome between 300,000 and 500,000 students, families and individuals interested in the new frontier of knowledge every year. Fondazione Agnelli had a key role in designing the educational labs, while Stellantis Foundation provided financial support as the project's biggest donator, according to John Elkann's decision, in memory of Sergio Marchionne.

All the information to freely take part in the HOP project and register for a training session in the 2023-24 school year (beginning in November) is available at the following link: www.hopscuola.it

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