PROCEEDINGS OF SCIENCE

Telling kids about Physics in interactive online communication formats

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Physics, especially Astroparticle and Nuclear Physics, is a theme rarely told to kids, because it is very far away from their everyday life and from traditional school subjects. Nevertheless, to answer the demand of materials to support distance learning during the pandemic, the INFN Communications Office widened its activities with interactive live streaming events and online workshops for students: an opportunity to involve kids, between 8 and 13 years old, into the discovery of Physics. During 2021 and 2022, in the context of a continuous toggle between in-person school and distance learning, INFN Communications Office explored different modalities to communicate science online, maintaining the focus on three main aspects: storytelling, interaction, and visual narrative. Three online projects were organized to provide teachers with new instruments to engage kids in Physics. The evolution of these three projects will be presented, focusing on the different narrative structures and modes of interaction. Also, the aspects of communication strategy, kids and teachers' engagement and perceptions will be discussed, by focusing on good results and critical aspects of the digital formats presented, in order to keep the discussion open on how they can be evaluated and aligned to school needs and expectations.

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1. Introduction

One of the objectives of science communication at the institutional level, as made by the INFN Communications Office, is to raise awareness of the value and impact of research, also transmitting the ideas of transparency and reliability of the scientific community. That is why it is essential to create opportunities for people of all ages to get closer to scientific research.

The experience gained during the pandemic has, on the one hand, strengthened initiatives that were previously only collateral to face-to-face communication programs, and on the other hand, confronted us with the need to involve an increasingly broad and varied audience in a non-random way. This is how the dialogues between researchers, the public and schools were born, aimed at narrating the research and physics made by INFN, and based on storytelling, visual narratives and active Q&A sessions. The mission to tell science stories has been particularly challenging when dealing with kids. Engaging them with fascinating but abstract ideas and concepts of physics is hard and risky; that's why science communication with kids is always made with the mediation of teachers and in a constant dialogue with them.

2. How to design online projects for schools? Storytelling, interaction and animations

The narrative structure is the core characteristics of all the outreach events (online and in person) realized by INFN Communications Office. With the aim of communicating high-level content in an accessible and pervasive way, the replacement of improvisation with pre-edited storyboards has become an indispensable practice to design online formats in which researchers dialogue with the public. Narratives have been considered as a structure of knowledge, a simulation of real experiences, a tool to persuade and a model for memory building [1][2]. The role of storytelling in engaging people and making every kind of topics, including science, attractive is well known [3][4][5]. Particularly, for educational activities the use of storytelling was also demonstrated to be useful to improve students' attention and memory [4] [6].

In the context of online events, as well as distance learning, the importance of keeping and improving the interaction with the audience is crucial [7], because it helps both the audience understanding the topic and building a feeling of closeness. This is the reason why all the online events for schools proposed by INFN Communications Office provide half of duration to be devoted to a Q&A session where students can ask questions by using the YouTube or Facebook chat which are answered by researchers during the stream.

The interactive storytelling is made even more effective by the use of images, graphics, animations, cartoons and visual demonstrations, suitably designed to intertwine with the editorial script. Visual narratives are key when it comes to high energy physics or cosmology, where images are rare or unreal and, at all scales, the concepts we use to describe the universe are hardly comparable to the common ideas we are used to. If adapt to the audience, scientific visualizations can improve both knowledge building and problem-solving skills [2]. Using animation together with the storytelling has been shown to be a potentially powerful tool to promote deep understanding in multimedia formats [8].

3. Projects

By focusing on storytelling, interaction between students and researchers, and visual narratives, during 2021 and 2022 INFN Communications Office developed three main different

communication formats, new instruments to engage kids in Physics: online workshops, "Ti racconto l'universo" ("Telling the universe"), and "La Fisica tra le Onde" ("Physics in the waves").

3.1 Online workshops

The possibility of bringing online workshops and manipulation activities for children aged 8 to 12 years old was explored as part of the educational program of science festivals in the autumn of 2021. We proposed 10 different activities, designed and implemented in collaboration with the "INFN Kids" project, coordinated by the INFN Third Mission Coordination Committee, resulting in a total of 20 sessions, covering various topics: from the structure of the atom to the history of the Universe, from electricity to light and sound. The activities consisted of a story alternated or followed by small experiments, such as the construction of a compass or a cardboard star projector. To preserve the interaction and the hands-on experience, we talk directly to the teachers who would follow the workshops, by providing a sheet of the activity, along with a list of the materials students would need in order to carry out the activity from their desk. We conducted the workshops by using videoconference platforms, leaving microphones and cameras on whenever possible, to allow the tutor and children to interact more easily. Children were always invited to interact and to approach the teacher's desk to show what they had realized.

3.2 An animated tale of research: "FisicaXKids" and "Ti racconto l'universo"

In the spring of 2022, we proposed to primary and secondary schools (children aged between 8 and 13) a series of three 50 minutes long live streaming events on YouTube named "Ti racconto l'universo". The focus of the project was accompanying the tale of physics conducted by researchers with images and animations designed for children. The project grew out from a previous one named "FisicaXKids", which was a great success in 2021, being followed by more than 200 classes for each proposed event. The two series explored an innovative hybrid approach in which the dialogue between children and researchers is introduced by a 15-20 minute video in which the researchers conduct a narration about their field of research supported by animations. The videos are also characterized by a strong visual impact, with tailor-made animations and the use of the chroma keying technique, which allows the insertion of images and scenarios in the background.

In both series, each event was independent of the others and self-consistent, and the children could intervene live with questions in the YouTube chat. The topics covered ranged from atomic physics to cosmology, from neutrinos to gravitational waves, and from dark matter to antimatter.

3.3 Experimental Physics told children by children: "La Fisica tra le Onde"

Approaching the experimental method through everyday life experiences and stories told by peers is the spirit behind the two series of "La Fisica tra le Onde". The project was developed in collaboration with an INFN researcher, Stefano Barberis, and his family, set off on an energetically self-sufficient boat from 2020.

The first series, "La Fisica tra le Onde - Energia", focused on the topic of energy, developed in ten 3-4 minute videos aimed at children aged 6 to 13. The series was published during the summer of 2021 on INFN Facebook and YouTube channels and in autumn, at the request of RAI, Italian main television broadcast, on RAI GULP channel during a kids' TV show. The second one, "La Fisica tra le Onde – I raggi cosmici", realized during the winter 2022, was aimed to tell kids

aged 10 to 13 about cosmic rays, a physics theme akin to INFN research topics. In this case, we extended the video duration to 5-6 minutes, and we organized a cycle of 5 live Q&A sessions on YouTube in which students could dialogue with a researcher.

In both series, each episode is supported by animations and tells a short story through a dialogue between the three children of the family on physics-related topics, always starting from their everyday life. In particular, the episodes of the second series are developed with a narrative structure that aims to emphasize experimental physics and the scientific method. Each episode begins with a question, which is answered by performing experiments. Then, starting from the results, the topic is explained and linked to an experiment in which the INFN collaborates, that was also the topic of the dialogue with researches.

4. Outcomes

4.1 Participation

The implementation of online activities had an immediate positive response and allowed us to involve a new audience – students up to the age of 13 and their teachers, who until then had not been the focus of dedicated activities by the INFN Communications Office.

Events	Classes connected during the live streaming	Number of interactions
Ti racconto l'universo		
1. Antimatter	175	406
2. Gravitational Waves	137	1.683
3. Cosmology	92	834
La fisica tra le Onde - I raggi cosmici		
1. What cosmic rays are?	170	200
2. Where do cosmic rays come from?	91	168
3. Which direction cosmic rays come from?	73	157
4. What stop cosmic rays?	62	88
5. Do cosmic rays live forever?	63	185

Tabella: INFN - National Institute for Nuclear Physics, Communications Office • Fonte: INFN • Creato con Datawrapper

Figure 1: The two projects were followed by students in their classrooms, so almost each connection actually corresponds to an entire class. The number of interactions was calculated by adding up three types of interactions: the chat messages and the channel subscriptions during the live streaming, and the number of "likes" obtained in the first two hours (there were no "dislikes").

The two series proposed in 2022 reached a very high number of classes. "Ti racconto l'universo" had a constant trend in terms of participation. For "La Fisica tra le Onde - I raggi cosmici" we noticed a drop in participation between the first meeting and the following ones but the almost constant participation during the last three events is a very good result because it means that at least 60 classes followed the entire path on cosmic rays with a five-week dedication. Furthermore, many questions were asked via chat, building up an interesting dialogue with the researchers.

The teachers participated with interest and willingness in the online workshops too, so we involved a total of 31 classes. We verified the activities effectiveness through discussions with teachers and direct observation of children's participation, which resulted very enthusiastic in most cases.

4.2 Usefulness, comprehension, and clarity

Both projects were considered valid and useful for teaching by most of the teachers participating in the questionnaire. More than 90% of the interviewed teachers found the project useful and 70% of them said they used it as a starting point for an in-depth discussion with their students.

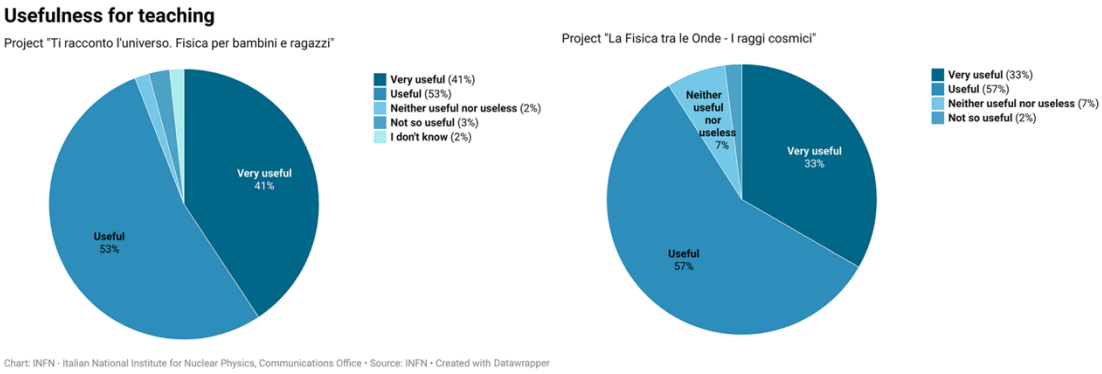

Figure 2: The diagrams represent the usefulness for teaching activities of the two projects, evaluated by a questionnaire filled out voluntarily by a sample of teachers.

Students' involvement and comprehension, surveyed through the views of the teachers participating in the questionnaire, were also between "high" and "very high" in most cases; involvement was slightly higher than understanding, a trend also confirmed by some comments.

For both projects, the introductory videos were rated as clear and appropriate for the purpose, and helpful in fostering students' understanding, whereas some comments highlighted that the expert's language during the dialogue was too complicated, especially for primary schools.

4.3 Building a strong connection with teachers

The implementation of online projects for secondary schools and primary schools resulted in many teachers subscribing to the dedicated mailing list and to INFN YouTube channel. 42 people subscribed for the INFN channel during the "La Fisica tra le Onde" live streams and 17 during the live streams of "Ti racconto l'universo", reaching around 70 new subscriptions in 24 hours in both cases. After the activities we usually ask the teachers if they want to keep up to date on INFN school initiatives by subscribing to the mailing list, and the online workshops in 2021 and the online projects in 2022 resulted indeed in an increment of secondary school and primary school teachers' subscription.

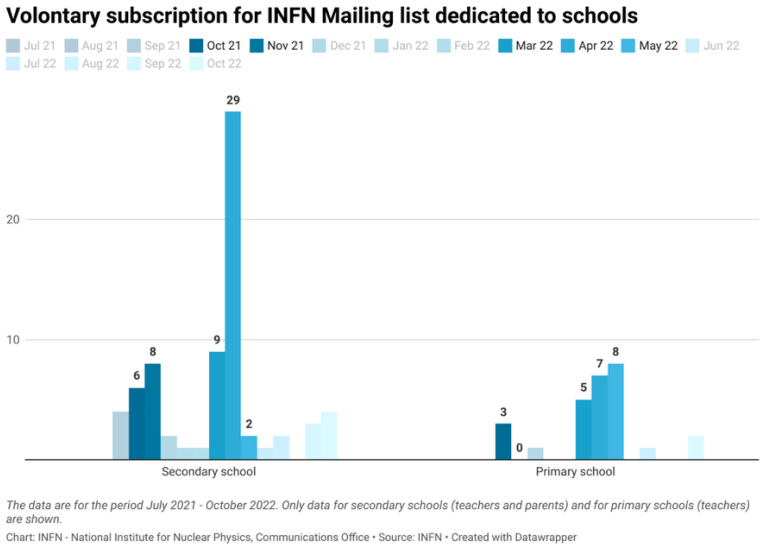

Figure 3: The histogram shows the voluntary subscriptions for INFN Mailing list dedicated to schools from July 2021 to October 2022. Only data for secondary schools and primary schools are shown. The moments when we proposed activities for schools (autumn 2021 and spring 2022) are highlighted displaying that enrolments were concentrated at these times.

For the project "Ti racconto l'universo" we also engaged new teachers before the project, by asking if they wanted to sign up for the mailing list during the project registrations. This method resulted in a great peak of subscription (more than 200 new teachers, most of them from primary schools) that confirms the interest and need of primary school teachers to get closer to scientific research topics and world. This peak is not included in the histogram above because it is out of scale, and it is not comparable with the other data**.**

5. Conclusions

The overall positive assessment of the projects conducted between 2021 and 2022 encourages further steps in this direction. However, data and information collected from discussions with teachers raise some points and reflections that may converge in new projects.

Proposing hands-on workshops remotely had the advantage of reaching even schools that have difficulties in joining in-presence festivals but presented the challenge of transferring online activities that were designed to be carried out in person. Anyway, in most cases the teachers' remarks collected after the workshops underlined their satisfaction. Both for "Ti racconto l'universo" and for "La Fisica tra le Onde – I raggi cosmici", the answers collected through the questionnaires confirm the validity of the projects structure but suggest more care in adapting the content and language to the target audience and a stronger interaction with the children. Although the meetings sometimes deal with topics that are not among those usually covered at school, they are indicated by the teachers as stimulating and capable of fascinating and interesting the students.

The success of the three projects and their structures is a sign of interest from schools in fundamental physics and scientific research, and online projects that aim to involve the youngest students through storytelling, supported by animations, and direct interaction with researchers. For these reasons, it can be considered as a good start in bringing the world of schools closer one of scientific research.

References

[1] J. Bruner, Actual Minds, Possible Worlds, Harvard University Press, Cambridge, MA, U.S.A. (1986).

[2] M. Farinella, *The potential of comics in science communication*, JCOM **17** (01), Y01, (2018).

[3] C. Cormick, *Who doesn't love a good story?,* JCOM **18** (5), Y01, (2019).

[4] A. Negrete, *Science via Narratives*, 7th International Conference on Public Communication of Science and Technology, PCST (2002).

[5] M. F. Dahlstrom, *Using narratives and storytelling to communicate science with nonexpert audiences*, PNAS **111** (2014).

[6] M. Glaser, et al., *Narrative-based learning*, Communications **34** (4) (2009).

[7] J.B. Arbaugh, R. Benbunan-Fich, *The importance of participant interaction in online environments,* Decision Support Systems **43** (7) (2007).

[8] R. E. Mayer, R. Moreno, *Animation as an Aid to Multimedia Learning*, Educational Psychology Review, **14** (1) (2002).