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FEATURE ARTICLE

Disney® Comics For Science

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ABSTRACT

In today's society, many young people are discouraged from enrolling in science, technology, engineering, and mathematics (STEM) faculties. As a result, there are not enough graduates in STEM faculties, increasingly in demand in a job market dominated by the advent of artificial intelligence algorithms. Reaching children and adolescents has the potential to create positive attitudes towards future STEM careers. This is the target audience of the project described, whose aim is to communicate the latest discoveries in science and space exploration through Disney® comics characters. The great interest and positive results produced by this project have inspired improvements for a more inclusive and science-enriched development.

Keywords: Particle physics; gravitational waves; Mars exploration; STEM; comics; ©Disney

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INTRODUCTON AND BACKGROUND

Fundamental research in science is often considered a complex and abstract field with little or no application to everyday life. This discourages many young people, especially girls, from enrolling in physics and, more generally, in science, technology, engineering, and mathematics (STEM) faculties. As a result, our society is lacking STEM professionals, who are increasingly in demand in a job market dominated by the advent of artificial intelligence and machine-learning algorithms. Children and young people up to the age of 13-14 are the target audience of the project described in this paper. Research [1] suggests that reaching young people before secondary school (up to age 13) can create more positive attitudes towards STEM fields, and interest in STEM careers. To reach the target audience more effectively, the author of this paper proposed a project in 2021 to the Italian division of the Walt Disney® Company. This paper reports on this project, the objectives of which are:

- to teach the target audience, through Disney®characters, about the latest discoveries in physics and space exploration;
- to convey the message that STEM fields are not always abstract, but have some concrete applications to everyday life;
- to study the potential of this education approach in a multilingual country.

Over the years, comics have become a consolidated tool for an innovative educational approach. The Italian division of the Walt Disney® Company pioneered this new educational paradigm. Their first contribution to science dates back to 1985 when they published a story entitled "*Topolino e l'acceleratore nucleare*" ("*Mickey Mouse and the nuclear accelerator*") in issue 1563 [2] of the Italian magazine "Topolino". This story explained the physics of the CERN Super Proton – Antiproton Synchrotron (SPS), to celebrate the 1983 Nobel prize in Physics awarded to C. Rubbia and S. van deer Meer for the discovery of the *W* and *Z* boson at the SPS. Following this successful science probe story, the same magazine continued its educational mission over the years with other stories on particle physics, such as "Paperoga e il bosino di Higgs" published in issue 2999 [3] in 2015, after the discovery of the Higgs boson at the Large Hadron Collider at CERN. More recently, they have reinforced this educational effort with the development of an entire science saga, *Comics&Science*, in collaboration also with the science journal *Nature*. It is in this saga that the project described in this paper frames in. Compared to sporadic stories, the creation of an entire science saga allowed to address more diverse topics in STEM-related fields. A recent data analysis showed that 53% of Facebook users who like comic books are female [4]. Therefore, this communication medium has the added benefit of inspiring little girls to future careers in science, seeking to improve the current gender gap in science.

Despite the achievement of all project objectives, possible improvements have been identified:

- Advanced topics cannot or can only by partially developed in the limited space of a single story. For better assimilation by the target audience, complex STEM topics should be disseminated more effectively in several stories, to be published with tighter timeline (*e.g.* weekly or

bi-weekly). This would give the target audience more time to search for further references and process the content.

- Interactions with the scientists, who developed the scientific contents, could be further fostered via dedicated remote or in-person events.
- To reach audience in more countries, the stories should be translated into more languages.
- For a more didactic approach, a direct involvement of schools and institutes should be planned.

PROJECT DESCRIPTION

The project was born during the COVID-19 pandemic in 2021, when the Principal Investigator (PI) of the project was at home in lockdown. After hearing the frustration of some family members in a phone call, they realized how stressful remote schooling was for parents and children. So, they thought it would be easier to reach kids in a world more familiar to them. The idea was to bring some of the most important scientific discoveries into the childrens' world, instead of forcing them to study science in a shared bedroom with their siblings. Remembering what they learnt as children from reading the Italian Disney® magazine "Topolino", they had not doubts about the appropriate communication medium. The general reader of this magazine is children and adolescents up to the age of 14. For this reason, they contacted the magazine's editorial board to propose this idea, which was enthusiastically accepted. Later, they produced a work schedule and publication plan. Leveraging their network, the PI contacted several colleagues from other disciplines, such as an Italian astrobiologist searching for life on Mars with current/future NASA [5] and ESA [6] projects, and a leader in gravitational-wave research working for the LIGO collaboration [7] in the USA. Using Disney® characters, children learned about the current Mars missions, muon particles, and gravitational-wave research. The project was carried out by the Disney® artists and scriptwriters together with the three scientists. The development of the three stories took about 2 years, from 2021 to 2023. The stories were published in 2022 and 2023. Fortunately, the COVID-19 pandemic ended at the end of 2022 and all lockdown restrictions were gradually removed, including remote schooling. Although the initial motivation of the project faded, the ambition and goals proved to be valid regardless of the pandemic. After identifying this successful communication medium, its potential to inspire the target audience about STEM fields was clear. This should help them making informed decisions when it comes time to enrol in high school first and university faculties later. To achieve this ambitious goal, the choice of the science topics was the result of a careful selection made by the PI on the recent discoveries and technological advances in the broad field of physics. Each story was followed by a news report in which the scientist involved provided more details on the contents developed in the story.

Given the recent Mars mission [5], whose Perseverance rover landed on Mars on February 18, 2021, the exploration of Mars was the first topic to be developed. In the following news report, more technical details on the latest NASA and ESA Mars missions, and their results, were given.

The second story to be developed concerned particle physics. As mentioned in the Introduction section, one of the aims of the project was to describe the applications of fundamental research to everyday life. Therefore, the story was about muography (*i.e.* muon radiography), an imaging technique that is becoming increasingly popular for applications to different fields, from art preservation, to archaeology and civil engineering. The story was published in July 2023, on the 11th anniversary of the discovery of the Higgs boson [8] [9]. In the following news report, the scientist explained the role of muons in the discovery of the Higgs boson at CERN in 2012.

The third story was about the detection of gravitational waves and the idea of space-time in the universe. The story was published in July 2023, on the 8th anniversary of the first gravitational-wave detection [10]. In the following news report, the scientist explained gravitational-wave detectors and the experimental technique in more detail.

METHODS AND DATA

The development of the three Disney®s tories was the result of several interactions among the three scientists and the Disney®/PANINI scriptwriters and artists. This was key to the success of the project. A story based solely on science content becomes too difficult for the target audience to understand in just a few pages. It is necessary that there are some jokes between different scientific contents in the course of the story's development. Similarly, the choice of Disney® characters must fit their well-known personalities with which the target audience can identify. For example, science contents are better explained by Gyro Gearloose, known as a scientist in the Disney® world, rather than Donald Duck. The latter is better suited to asking spontaneous questions, the same ones the ordinary reader might have. For this project, all this was natural, since the three scientists were all avid readers of the comic magazine. Being familiar with the personalities of the main Disney® characters, they could already propose the most suitable characters to the Disney® scriptwriters.

Each scientist used the latest references available in the literature of their fields to produce realistic science content. In this way, interested readers could search and learn more about the subject after reading the story. To further enhance the learning experience, readers were

invited to send their questions to the three scientists via the magazine's email address.

RESULTS

This section provides more details on the project results, the three stories and their scientific content, and the feedback received.

The first story, entitled "*Zio Paperone e le Acque Marziane*" ("*Uncle Scrooge and the Martian Waters*"), concerned Mars exploration. It was published in issue 3477 of the magazine [11], in June 2022. The story illustrated some of the key points of the current Mars missions, whose ultimate goal is to search for signs of microbial life, collect rock and soil samples, and prepare for future human exploration. With the support of the scientist, the story was as accurate as possible in the descriptions of physics ideas, instruments and challenges. After landing on the planet, the Disney® characters use various instruments, such as the X-ray diffractometer to analyse the mineralogical composition of the Martian soil and rocks, or the gas chromatograph to separate gasses in order to identify them and analyse the atmosphere, or even the mass spectrometer used to detect key elements necessary for life in Martian waters. These are quite accurate instruments when compared with those of the NASA Perseverance rover [5] or other ESA Mars missions [6]. Similarly, the design of the PdPIONEER spacecraft is inspired by the Orion [12] and Starship spacecrafts [13]. A selection of comic strips taken from this story is shown in Fig. 1. In the subsequent news report, more details were given on the latest Mars missions and their findings.

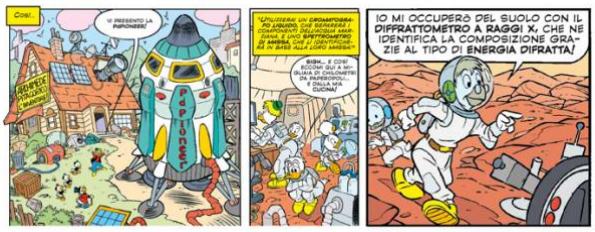

Fig. 1. Selection of comic strips taken from "Topolino" issue 3477, "*Zio Paperone e le Acque Marziane*" [12], ©Disney®.

The second story entitled "*Zio Paperone e l'Inghippo del Muone*" ("*Uncle Scrooge and the Muon Issue*") was about particle physics. It was published in issue 3527 of the magazine [14], in June 2023. Cosmic muons are fundamental particles produced by the interactions of cosmic rays with the Earth's atmosphere. Similar to electrons, but about 200 times heavier, these particles can penetrate much greater thickness of matter. This has been exploited to produce muography, a non-invasive imaging technique for scanning solid objects, such as pyramids, volcanos or buildings, by producing density maps. Inspired by a recent feasibility study to apply the technique to the Dome of Santa Maria del Fiore in Florence, the scientist came up with realistic calculations on the angular distribution of cosmic muons and the days required to produce a high-resolution muography of Uncle Scrooge's Money Bin. The Disney® counterpart of CERN, *CERP, "Centro di Eminenti Ricerche Paperopolesi"* (*i.e.* "*Institute of Duckburg Eminent Research*") - provided Disney® characters with the muon detectors. In a limited number of pages, both muography techniques - muon radiography and muon tomography – are described. A selection of comic strips taken from this story is shown in Fig. 2.

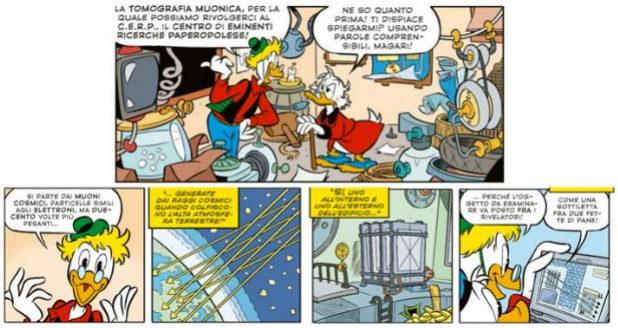

Fig. 2. Selection of comic strips taken from "Topolino" issue 3527, "*Zio Paperone e l'Inghippo del Muone*" [14], ©Disney®

The third story entitled "*Sogni D'oro, Zio Paperone*" ("*Sweet dreams, Uncle Scrooge*") was about gravitational-wave physics. It was published in issue 3538 of the magazine [15], in September 2023. Gravitational waves (GW) are small perturbations of the flat space-time traveling at the speed of light. Given the Disney® character involved, Uncle Scrooge, the production of gold from GW sources is also discussed. After describing the physics ideas, the story deals with applied problems, such as traveling large distances in the universe with the available technology. Ample space is given to the description of the interferometric gravitational-wave detectors. Inspired by the VIRGO and LIGO detectors, Uncle Scrooge supports the construction of a gravitational interferometer at Duckburg. Later, how to distinguish a signal from a large background is also explained. This is useful knowledge for many STEM fields, not just physics. A selection of comic strips taken from this story is shown in Fig. 3.

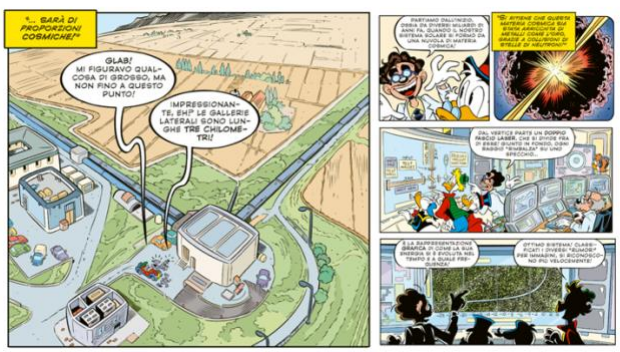

Fig. 3. Selection of comic strips taken from "Topolino" issue 3538, "*Sogni D'Oro, Zio Paperone*" [15], ©Disney®.

The project was promoted on the Disney®'s social media with dedicated posts, for example [16]. The latter were also promoted on the social media of INAF ("Instituto Nazionale di Astrofisica"), CERN and "EGO & the Virgo Collaboration" through liking the posts and sharing of the Disney®post. Several Italian science bloggers delved into the physical content of the stories in more details, for instance in [17]. Later, the project received the attention of Italian newspapers [18], the CMS collaboration [19] and ETH Zürich [20], who wrote some articles to inspire other scientist in similar outreach and pedagogical activities. Tab. 1 summarizes some statistics about the posts on the social media from the CMS collaboration. In September 2023, a Swiss journalist produced a TV report on this project, which aired on the main newscast of the Italian canton [21]. This triggered requests for guided tours of the CERN laboratory. Some of them came from parents of children who read the stories.

The collection of questions from readers is still ongoing since more time has been allowed until a few months after the publication of the last story. The answers will then be published in another issue of the magazine. According to the current feedback received, 40% came from female readers.

Table 1. Project results, based on the social media from the CMS collaboration, who wrote several posts.

Social Media	Impressions/Likes
Facebook	4653/85
LinkedIn	2293/36
Instagram Story (24 h)	1167/--
Twitter (X)	1755/10

DISCUSSION AND CONCLUSION

This paper described a recent project that uses Disney® characters to communicate science to young people, with the aim of arousing their interest for STEM subjects. While the use of Disney® comics for educational purposes has already been tested in sporadic stories in Italy, this project developed a saga of three stories describing recent discoveries in particle physics, gravitational – wave detection and Mars exploration, with the help of three scientific advisors. The project also facilitated the interaction between readers and scientists through questions sent by email. The outcome was positive, gaining media attention and producing good interactions with the public on social media where it was promoted. It generated interests in science topics, which also continued with tours organized for some young readers at CERN. The positive results in Italy and Switzerland should be enhanced with a multilingual follow-up project, including more science topics to be translated into different languages, from French to German, to English. For better assimilation by the target audience, more complex STEM topics should be developed in several stories, to be published with tighter timeline. Additional educational developments involving schools are being tested in Zürich by the PI, in collaboration with the Italian Consulate General in Zürich. One of the stories was read and discussed in class by students and teachers, who expanded on the scientific content. The PI and the scientific advisor to the Italian Consulate General in Zürich will later meet the students to answer any questions they might have. This is a probe sub-project, based on a limited number of schools and one story. If successful, it could be extended to more schools and stories.

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