
HEPScape: an escape room about high energy physics

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Abstract

Escape rooms are more and more popular nowadays. They have the challenges of a treasure hunt and represent a pleasant way to encourage team building. In addition they are a fun way to discover a new subject, a key point that can be exploited for science outreach. In 2021 a team from INFN has built an escape room about high energy physics, called HEPscape. The visitors have the impression of visiting the Large Hadron Collider at CERN and of entering one of the experimental control rooms. It makes use of projectors and posters which replicate the control room environment. Through some clues, that are hidden in the room, the visitors discover the purpose of particle accelerators and high energy physics experiments. The games can be tuned to the age group, resulting in a fun experience for everybody. HEPscape is made of portable equipment that can be transported and assembled in less than two hours. This allows to use it in science fairs and exhibitions. In addition it can be brought on demand to high schools in remote provinces. The material and the format of the games are simple and it is possible to replicate and translate the games in other languages. Feedback and experience from two science fairs is presented.

Keywords

High Energy Physics, Outreach, Escape room

Introduction

In contemporary world, teaching methods have not evolved as fast as the new communication methods that the young generations adopt. The perception that the students may have of old-fashioned frontal lessons is therefore not enthusiastic, particularly for what concerns scientific subjects. New teaching methods that make use of active discovery of the subjects may help stimulate the curiosity of the students, and convey the idea that studying scientific subjects is fun.

Since a few years escape rooms have become very popular in most cities. An escape room is like a treasure hunt in a closed room. The team must solve a series of puzzles and quizzes within a given amount of time, in order to open the room door and escape from the site. The activity is often guided by an external moderator who helps the team from outside to find the clues hidden in the room and solve them in time. Escape rooms are so intriguing and fun that they are also often used by adult co-workers as a team building exercise. Usually the room has an underlying theme and decoration: ancient history, detective story, crimes eccetera. In the past few years escape rooms were adopted by few teachers as an unconventional method to teach a new subject through active discovery, see for example [2] and references therein. For the initial overview of a subject they have proven to be very effective. This fact can be exploited for science outreach.

In 2019 a team proposed an escape room to the Open Day visitors. In 2020 a similar attempt was made by a team from the CMS experiment for a high school student internship. In 2021 a group from INFN Rome put up an escape room, named HEPscape [1], and brought it to two science festivals in Italy with great success, as explained in this paper. More

than 1100 visitors participated in the activity in Rome and Genova.

Escape room setup

HEPscape can be installed outdoor in a gazebo or indoor in an adequate room. The required space is about 25 m². The visitors are welcomed outside the room, they are given a helmet and they are told that they are going to visit the LHC, the largest particle accelerator in the world, which is located in an underground tunnel. The door of the escape room is made with a PVC curtain showing the image of the LHC tunnel. Inside the room there are many posters hanging on the walls, showing photos of the LHC and its experiments, as well as some important information which is needed to solve the games: the table of chemical elements, the constituents of matter, the structure of the atom, and the quark structure of the proton.

Three projectors are installed in the room: the main one is installed on the largest wall, with two smaller projectors one on each side. A few LED lights controlled via bluetooth are installed in the room and are used to guide the attention of the visitors to the clues, or to create special effects.

The HEPscape moderator is inside the room and guides the visitors through the activity. One or two extra persons are needed to control the room lights and projectors. As soon as

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the visitors are seated, the game starts. All three projectors show the movie of the lift going underground in one of the LHC pits, courtesy of the CERN superconducting magnets SM18 visitor point. The 3D effect of the moving lift video projected on 3 walls is spectacular.

The game

There are two game sets: one for younger children, starting from 8 years old till about 11, and one for teenagers and adults. Several locks are hidden in the room. They are closed and can be opened through a numeric code. Everytime a lock is opened the visitors find an explanation about the scientific content that they have utilized to open the lock.

The main projector is used to show the game content and videos where scientists explain the working principle of the particle accelerators and detectors. The lateral projectors show a movie of the interior of the CMS control room. This was filmed by CMS outreach in 2021 with a 360 degrees projector, and then reframed to show the two opposite sides of the room. The movie shows people working in the control room, and moving from one side to the other, so that visitors have the impression of being inside the CMS control room.

The solution of the next three games allows to open three locks equipped with a numeric combination. In the locks the visitors find a few pieces of a magnetic puzzle representing the CMS experiment, as well as some scientific content about high energy physics.

The first game consists in guessing how deep the LHC tunnel is. The adult game shows a system of mathematical equations made with photos of the tunnel and the magnets. The kids game has a simpler set of clues.

The second game is about the LHC magnets. A cross-word allows to discover that the magnet coil is made of a Nb-Ti alloy. Using the atomic number of these elements one can open the lock.

The third game is about the Standard Model of particles, and in particular the visitors must find the constituents of the proton which are represented using plastic balls with different labels and weights. Once the game is solved, a movie shows on the main projector how the protons are accelerated and collide in the LHC.

The final game is about the Higgs boson. The moderator explains to the visitors that the Higgs boson is unstable and it may decay into other particles which are then observed in our detectors. In particular the decay that they must search for is the decay into four muons. Some events are shown on the main display with different number of muons. The visitors count the number of muons they see in each event, until they finally identify a candidate Higgs boson event with four muons. Finally the video of the announcement of the Higgs boson discovery at CERN on the 4th of July 2012 is shown on the main projector and the big applause of the auditorium concludes the game.

Usually at the end of the game there are ten minutes of discussion when the moderator answers the questions of the visitors.

The scientific content of the game is related to all the LHC experiments, in fact the movie of the LHC pit was filmed in Alice, the animated movie of the four muon event is from

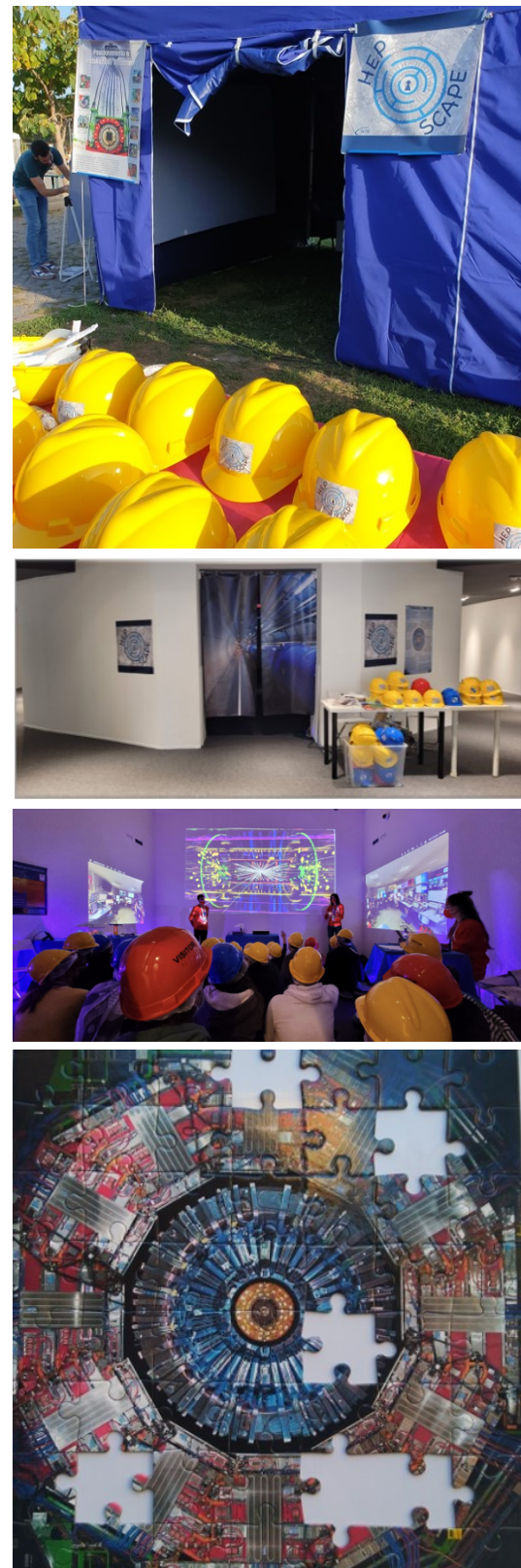


Figure 1. Photos of the escape room (top to bottom): HEPscape installed outdoor in a gazebo, entrance of the escape room installed indoor at the Genova science festival, photo of the activities, CMS magnetic puzzle.

Atlas, the kids game about symmetry is inspired to LHCb and the other content is from CMS.

Results of the satisfaction test

At the exit of the room there is an Instagram photo booth and a tablet for a satisfaction survey. The survey is made of two questions: the age group and the satisfaction in a scale of 1 to 5.

The results of the survey are shown in Figure 2. The top figure shows the satisfaction test of the first two days of the Genova science festival, where most of the visitors were school classes with their teachers. The escape room was set up according to the age of the class. The center figure shows the satisfaction test of the third, fourth and fifth day, when mixed groups did the activity: families with kids, groups of friend and people interested in science. Because the groups were mixed in these last days, the escape room was always configured with the adult setup. The bottom figure shows the total distribution of the satisfaction test. Overall the visitors liked the game, and the average mark was 4.4/5. It is clearly visible that the young age groups liked very much the setup adapted to their age (top plot) compared to the adult game (center plot). In addition, not all of the teenagers in the school groups (top plot) liked the activity, while those in the mixed group liked it. In general the mixed groups enjoyed more the activity than the school groups, probably because of their stronger motivation and interest in science.

It would be interesting to collect a feedback on the scientific content of the escape room, by checking if the visitors retain the game scientific content. However this simple two-questions survey is a compromise that collected a high statistic of responses, while having a simple feedback on the satisfaction of the visitors.

Future plans

We plan to bring the escape room to several science festivals in 2022 (Rome, Genova, Napoli) and to open HEPscape on reservation for a short period of time to the schools in the Lazio region. We plan to translate the escape room games in other languages, including the language of signs. We are going to share the instructions and the content of the games and make a network of interested persons who will access and share the games that are invented.

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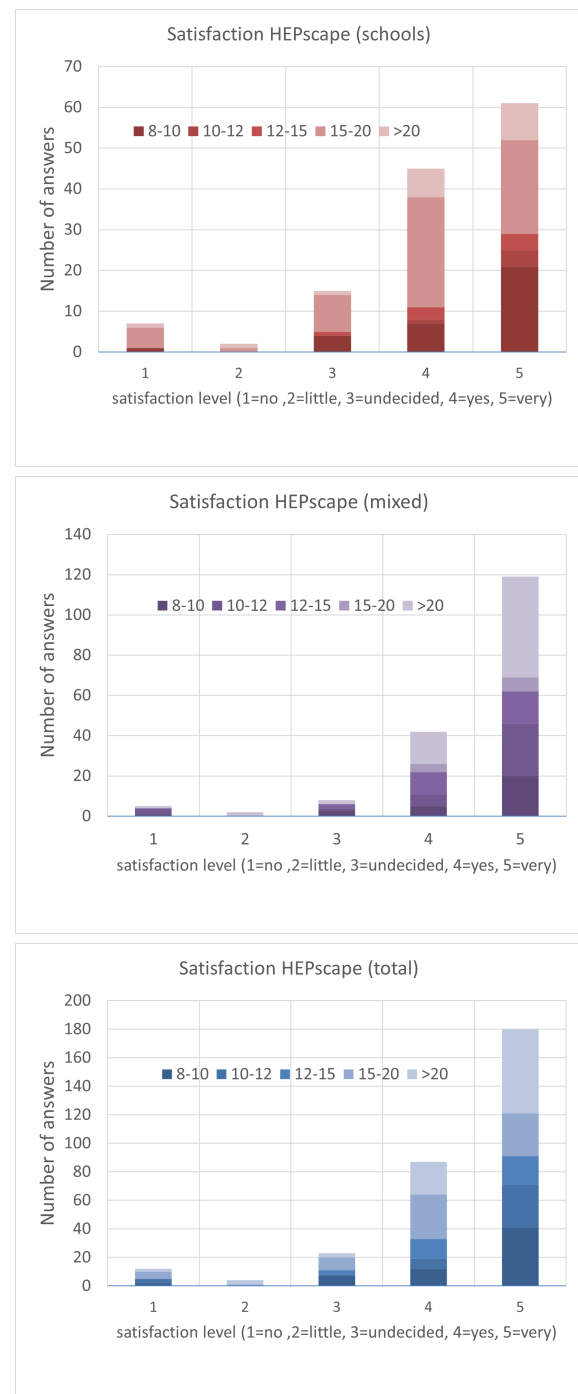


Figure 2. Result of the satisfaction survey in a scale of 1 (not at all satisfied) to 5 (very satisfied). The top plot shows the votes of the first two days of the Genova science festival, when the visitors were mostly school groups. The center plot shows the votes of the third, fourth and fifth day of the festival, when the attendance was mixed. The bottom plot shows the total distribution of the votes. Age groups are indicated in the legend.

References

- [1] <https://web.infn.it/hepscape/>
- [2] Alice Veldkamp, Marie-Christine P. J. Knippels and Wouter R. van Joolingen, *Beyond the Early Adopters: Escape Rooms in Science Education*, Front. Educ., 11 March 2021, <https://doi.org/10.3389/educ.2021.622860>