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The International Astrophysical Online Code Hunting Game and the Astrophysical Cody Maze

Two innovative resources to promote computational thinking, digital skills and astronomy dissemination

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Abstract. As part of its Third Mission, the National Institute for Astrophysics (INAF) fosters the development of social, educational and cultural products to be made readily available to the public. In particular, the Play.Coding working group has been supporting the creation of digital resources that not only disseminate astronomical content (fig. 1), but at the same time allow users to practice computational and digital skills. This paper presents two resources that were produced in the last two years within this context and are available free of charge on the Play INAF website: the international Astrophysical Online Code Hunting Game and the Astrophysical Cody Maze, developed in collaboration with the University of Urbino and the university spin-off DIGIT srl.

Key words. Coding – Computational thinking – Digital skills

1. Introduction

As part of its Third Mission, the Italian National Institute for Astrophysics (INAF) fosters the development of social, educational and cultural products to be made readily available to the public. Astronomy is one of the sciences that most fascinates the media and the general public, with a huge potential as an effective multidisciplinary teaching topic for schools of all levels. Due to the curiosity and fascination it arouses in young people, it can be a valid tool to prevent early school leaving (Bhathal (2011); Molla et al. (2022)) and the tendency to abandon studies in the scientific area that is occurring in many European countries (European Commission (2022)).

In addition to that, the INAF Play.Coding working group focussing on innovative teaching has been supporting the creation of digital

resources to disseminate astronomical content and improve digital skills. Such resources promote the development of computational thinking mainly through coding, a very powerful tool that opens minds, develops intuition and stimulates curiosity, which can be used across disciplines, not just the STEM ones (science, technology, engineering and mathematics).

This paper presents two resources that have been produced within this context and are available free of charge on Play INAF, the website for innovation in education of the National Institute for Astrophysics: the international Astrophysical Code Hunting Game and the Astrophysical Cody Maze, both developed in collaboration with the University of Urbino and the university spin-off DIGIT srl.

2. The International Astrophysical Code Hunting Game

The Online Code Hunting Game is a multiplayer game that promotes digital skills and computational thinking (Klopfenstein et al. (2018)). Borrowing the structure of a traditional treasure hunt, it poses challenges that players have to solve using the logic of computer coding in order to move around the map of a particular geographical territory. To play the game, users need a smartphone, tablet or computer, a QR code reader with a camera, an internet connection and the Telegram instant messaging application.

We decided to customize this format to the astronomical context, first in Italy and then worldwide (Mignone et al. (2022)). In 2020, we created the first Astrophysical Code Hunting Game, an online game to engage the public with the historical and current practice of astrophysics across the Italian territory. The game was first presented during the European Researchers' Night 2020, as a response to the lockdown and social isolation measures enacted to prevent the spread of Covid-19. Unable to plan in-person events, the team chose this online format as a public engagement tool to connect remotely with individuals, families and schools, enabling players from everywhere in Italy to discover the many locations around the country linked to astrophysics: astronomical observatories and research institutes, planetaria, museums, the birthplace of notable Italian astronomers, and more. Each match includes a series of coding puzzles alternating with astronomy-themed quizzes to find 8 notable places on the map. The game encourages all sorts of problem solving strategies: players who are not familiar with a particular astronomical event or locations may try to solve a quiz by browsing potential candidates on the map, seeking information online, or asking the bot to provide a hint. The game can also be played in the classroom: users may play either competitively or collaboratively, individually or in teams, trying to finish the match before the others.

Building on this experience, we further expanded the concept in 2021, developing a global game to explore over 300 locations linked to astronomy around the world: the first international Astrophysical Code Hunting Game. Presented during the European Researchers' Night 2021, it is a unique endeavour whose development involved more than 70 astronomy researchers, communicators and enthusiasts from over 30 countries. This online treasure hunt bridges worldwide distances, providing the public with the opportunity to play together and discover the places that have written the history and are shaping the future of astrophysics.

The map comprises over 300 "pins" in over 60 countries, covering all continents, including Antarctica. It includes famous observatories, archaeological sites and renowned researchers that have made the history of astronomy, but also hidden gems – small observatories, public sundials, astronomically relevant monuments, little known figures and stories that are only known at local level – and even the sites of meteorites that, from the vast reaches of space, have ended their journey on planet Earth. The international version of the game is currently available in Italian, English, French, German and (partly) in Spanish; locations in Catalonia are also provided with a translation to Catalan. At the time of writing, over three hundred teams have played at the International Astrophysical Code Hunting

Fig. 1. The map of 100 locations in Italy (left panel). The map of 300+ locations around the world (right panel). Click on the QR codes to play. Credits: INAF.

Game: these may include individual teams but also groups as large as a school class.

3. The Astrophysical Cody Maze

The Cody Maze is a virtual labyrinth in the real world, enabling players to approach coding in a light and fun way. The Astrophysical Cody Maze, which complements the format with quizzes about astronomy, astrophysics and space exploration, is a powerful educational tool that combines coding skills with astronomy dissemination. It can be used free of charge, in schools or during events, indoors or outdoors, ensuring the public engagement of a very wide audience, from children to adults. Astronomy quizzes may be used in school to brush up on the science program and learn many interesting things about astronomieral citiescal objects, while coding challenges allow players to get closer to the logic of programming and develop computational thinking. The game consists of 25 QR codes, each with a different astronomical background, that can be downloaded and printed from the Play INAF website. They must be arranged on the floor in a 5×5 square grid, at least 50 centimeters from each other. In this way, players can move inside this chessboard-like structure. The columns and rows of the chessboard are identified by letters and numbers, starting from the top left corner, as reported in Fig. 2. Each QR code is assigned a position and an astronomical topic (planets, asteroids, nebulae, galaxies, constellations, and so on). The chessboard is oriented so that the upper side corresponds to the North and the lower side to the South, the left one to the West and the right one to the East.

Players interact with the game using their mobile device and the Telegram app: the goal of the game is to get out of the virtual labyrinth, following the instructions provided by a Telegram bot, that should be interpreted and executed correctly. The game starts by scanning any of the QR codes at the chessboard edge. The bot proposes a multiple-choice quiz about astronomy. Each box of the labyrinth is characterized by a different topic, including a total of 250 astronomy quizzes. In order to proceed along the labyrinth, the player must answer correctly. Then, players receive a series of instructions to physically move on the board: once they have completed each instruction,

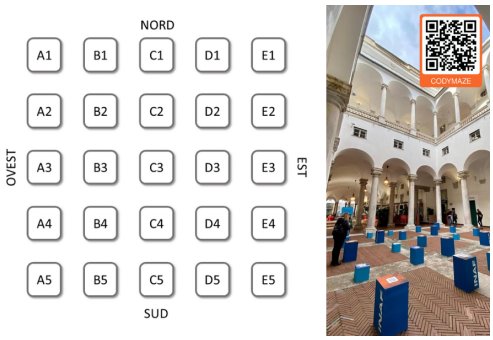

Fig. 2. QR code distribution scheme (left panel). First installation of the Astrophysical Cody Maze, presented during the Genoa Science Festival in October 2021 (right panel). Credits: INAF.

scanning the QR code of the box they landed on enables to verify whether the sequence of instructions has been correctly executed. The sequences of instructions provided by the bot are of increasing complexity, introducing all the basic concepts of programming: elementary instructions, repetitions, nested constructs, conditions, and conditional repetitions. Also in this case, the requirements to play the game are a smartphone or tablet with data connection, a camera, a QR code reader, and Telegram messenger.

By enabling players to physically enact instructions formulated in computer programming language, this is a powerful example of an embodied, coding unplugged (Bell et al. (2009)) activity that entertains audiences of all ages. The limit to the number of players is only given by the dimensions of the chessboard on which players should move independently, each one following the instructions provided by the Telegram bot. The Astrophysical Cody Maze was first presented in October 2021, during the Genova Science Festival. During the European Researchers' Night 2022, INAF presented the Astrophysical Cody Maze in several cities (fig. 3 – Bologna, Cagliari, Padova, Roma, Trieste – and, at the time of writing, 2077 participants played the game.

References

Bell, T., Alexander, J., Freeman, I., & Grimley, M. 2009, Computer science unplugged: School students doing real computing without computers. New Zealand Journal of Applied Computing and Information Technology, 13(1), 20-29.

Bhathal, R. 2011, Improving the scientific literacy of Aboriginal students through astronomy. Proceedings of the International Astronomical Union, Volume 5, pp. 679 – 684

European Commission, Directorate-General for Education, Youth, Sport and Culture (2022), Education and training monitor 2022: comparative report. Publications Office of the European Union

Klopfenstein, L. C., Delpriori, S., Paolini, B. D., & Bogliolo, A. 2018, Code Hunting Games: A Mixed Reality Multiplayer Treasure Hunt Through a Conversational Interface. Internet Science. INSCI 2017. Lecture Notes in Computer Science, vol 10750. Springer, Cham.

Mignone, C., Sandri, M., Bandiera, R., Bogliolo, A., Casu, S., Fulco, M. T., Giobbi, G., Klopfenstein, L. C., Leonardi, L., Malaspina, M., Toniolo, R. & Trinchieri G. 2022, The first international online Astrophysical Code Hunting Game. GARR Conference Proceedings 13

Molla, M., Amperiadis, P., & Kyriazopoulou, G. N. 2022, Astronomy Workshops: Implementation in Greek Primary School, Europlanet Science Congress 2022, Granada, Spain, 18–23 Sep 2022, EPSC2022-1212

Fig. 3. Some installations of the Astrophysical Cody Maze: Roma and Padova (upper panels), Matera and Cagliari (middle panels), and Palermo (bottom panel). Credits: INAF, ASI, IEMEST.