ASTROEDU

Peer-reviewed Astronomy Education Activities

Driving on Mars

An educational interdisciplinary game to drive a rover on Mars

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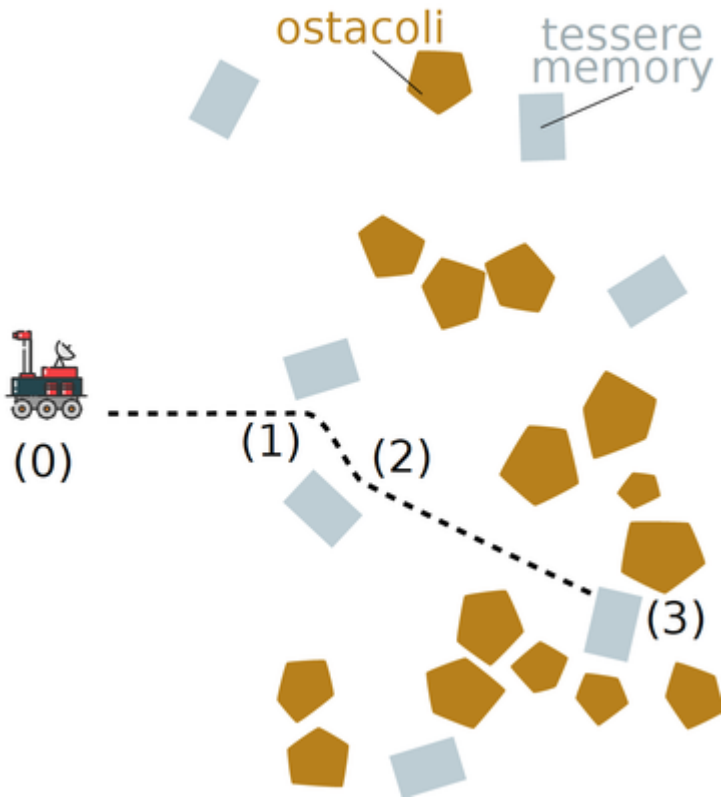

KEYWORDS

ritardo temporale, marte, telecomunicazioni, luce, rover, gioco di movimento

LOCATION

Ampio spazio al chiuso (per es. atrio scolastico)

TIME

2h

GROUP

Gruppo

SUPERVISED

Sì

COST

Basso

GOALS

- Get to know the problems caused by the delay in space missions.
- Learn the importance of an adequate planning.
- Learn to collaborate and plan within a group.
- Acquire information and knowledge about the planet Mars.
- Approach science in a playful context, with multidisciplinary aspects.

LEARNING OBJECTIVES

- Understand that radio signals, both on Earth and in the space, travel with a con finite speed.
- Realize the need for an adequate planning of the mission.
- Understand the need for a proper planning in exchanging messagges between the probe and the control centre.
- Learn to establish priorities in information, while acknowledging the essential ones.
- Acquire knowledge and information on the conformation of the surface of Mars, in particular what sets it apart from the Earth.
- Learn the scientific importance of the search for water on another planet.

BACKGROUND

Telecommunications. Radio signals, the same used for some communications on Earth, travel at the speed of light, which is not infinite, but very high: about 300.000 km/s.

Just as we turn on a light bulb we dot not realize the time elapse between the light release and the reception of the light signal, in the same way, as we send a radio signal on the Earth, this signal covers very large distances in a very short time, so much so that it seems that the arrival at destination isi istantaneous: when we drive a

remote-control car, we seee that it responds instantantly to our commands.

This is very convenient: if the remote-control car is running towards a wall, just give it the braking or steering control.

On the other hand, the situation changes if we must send radio signals to a rover which is on the planet Mars: indeed, it is 54,6 millions km far when it is closer to the Earth, and 401 millions km far when it is further away.

This implies that, in order to go from the Earth to Mars, a radio signal takes from 4 to 20 minutes, according to the reciprocal position between the two planets (the same delay with which we see the image of Mars, if we observe it with a telescope: we do not see the planet as it iw now, but rather as it was 4-20 minutes ago).

If we return to the aforementioned example, if a remote-control car on Mara is running towards a wall, and sends us a message to ask for help, we notice it with such a delay that, probably, our car will have suffered an incident in the meantime!

Mars and the search for water. In the current exploration of the Solar System, it is particularly important to search for water under the rocky surface of Mars (2, 3) through rovers, which are controlled from Earth through radio signals.

For the life on our planete, in fact, water is of vital importance: if we find water on another planet, this would indicate that it has been or still is inhabited by living creatures, even through simple ones.

In fact, more and more scientific evidences regard the presence of rivers and lakes in the past of the Red Planet: the pictures collected by space probes show shapes which, after a careful morphological analysis, have been identified as beds of ancient rivers, lakes and seas. Moreover, liquid water has recently been discovered in underground lakes in the polar regions, through the observations of the italian radar Marsis by the Mars Express probe, of the same type of the observations used on the Earth during the explorations of the Antarctic. This has been possible thanks to the exceptional conditions of salinity and pressure (0).

Rovers. The rovers sent from the Earth are often produced by International collaborations, which involve joint work of large teams of scientists. Once abandoned the Earth, they can only be controlled remotely and send information: in case of breakage or other problems, indeed, sofar it is impossible, to send up scientists to repair them. It is therefore very important to adequately plan the system of communication betwenn rover and the control centre, so that the exchange of information is as fast and efficient as possible, and accidents can be predicted.

Space agencies. Space agencies are responsible for designing and implementing these space explorations. The most famous agencies in Italy are the US agency NASA (1) and the European one, ESA (4,5). There are other very important space agencies: the Japanese JAXA and the Russian one ROSCOSMOS.

The most famous NASA rover is called Curiosity (6), whereas the ESA rover, whose landing is expected in 2020, is part of the Exomars mission (7,8).

The most famous NASA control centre is in Houston, while the Exomars control centre is in Turin (5).

FULL DESCRIPTION

Preparation

You can prepare materials and spaces for the rover construction by using cardboard, scissors, cutters, glue, adhesive tape, water paint, brushes and logo of your favourite space agency.

The carton must be open above and below, and have two openings on the sides to pass the arm, or else you can make suspenders with twine.

Step 1: test on Earth.

We test the system of communication between rover and control centre in a very limited area (for example a classroom or just a room). We distribute a few obstacles with some water-earth memory card, face-down, nearby Mission Control, properly defined.

Next Steps.

We spread hurdles over the whole play area, conveniently far from Mission Control, and several water-earth memory cards, face-down.

General issues.

The goal of the game is finding water on Mars. Children will be able to choose among three types of roles: mission control, rover and messengers, and will be identified by cards. Mission control and rover will have to help each other, through messages with which mission control will give instructions to the rover, and the rover wil provide mission control information about the features of the place in which it is, in order to reach the final goal.

Communication takes place through messengers, who will have to shuttle from one to the other, moving quickly to carry messages. The rover will move on the martian ground and will check the presence of acqua (turning the memory cards appropriately distribuited) time and again on instruction of the mission control when it reaches the cards.

Step 2. Duration: 20 minutes

We explain the mission to the team: moving the rover in the martian ground, searchinh for water, and inviting children to agree on the communications which will be exchanged between rover and control centre.

At this stage, we want to make pupils think far about a peculiar feature in space missions – namely the importance of planning on Earth, insomuch as, once we launch the probe, it won't be possible to intervene *in loco* in case of failure or malfunction.

We explain that in real missions, a test in Earth is always made, thus highlighling that, with this activity, we retrace correctly the operations carried out by scientists.

Before sending the rover on Mars, we propose a trial run on the Earth: the control centre will have to send out some messages to the rover, not far from them poco, always mediated by the messenger. This stage simulates the exchange of signals on Earth, where ther message arrives very quickly, and the control centre can see the effects of the instructions in real time, therefore the chance to make corrections.

Instructions will in any case be communicated through the messenger, so as to highlight the fact that the mode of signal transmission is the same.

With reference to this a stage, we can tell of the Soviet Rover in Chernobyl (see the section "Furtheri Reading").

At first, students are asked to define the rules of communication between the control centre and the martian rover, giving priority, for example, to the safty of the probe.

Step 3. Duration: 10 minutes

Il rover viene portato sul suolo marziano (la zona lontana dal Controllo Missione) assieme ad almeno un messaggero. Gli viene data istruzione di segnalare al controllo missione di essere atterrato e di essere in buone condizioni.

Il rover scrive quindi il primo messaggio al controllo missione e lo spedisce tramite il messaggero, aggiungendo ogni dettaglio che ritiene adeguato.

Step 4. Duration: 30 minutes

At this point, the mission control should tell the rover how to move, according to the information received by the rover itself.

Ample freedom is given to participants as to the information which should be sent in the messages and the path to follow.

Pupils will be encouraged to analyze the situation in a collaborative perspective among “control centre” group, “rover” group and “messenger” group, so ad to reach the final goal in the shortest possible time.

If the rover signals that it is approaching a point apparently suitable for searching water (“water-rock “ memory card), mission control can give the instruction to pursue the search (turn the card over).

If the rover hits an obstacle, you must exchange two outward messages and two return messages before you can start again, simulate the time necessary to understand any damages to the rover.

By the time water is found, the mission ended successfully.

If after the time is elapsed and no water has been found, the game is stopped.

Step 5: 40 minutes

The teacher analyzes, together with the pupils, criticslity and strengths of the various phases of the game, and of the different working groups, possibly suggesting a more effactive way of proceeding with operations. Childred are asked to think about the complications arise, with reference to Step 1 too, when the rover was still on the Earth. (See “Supplementary material”)

A new “manche” is therefore proposed in order to ascertain that the communication problems among the various groups have been overcome (repeat steps 2 and 3) with a shorter run time. In this new manche roles can be changed, or else can remain the same.

EVALUATION

The acquired knowledge is consolidated through a conversation and reflection according to the mathematic dialogue with the teacher, based on the following questions:

- What kind of problems came up during the activity? - Why did some things go wrong?
- Were there any messages you received (either from the rover or from the control room) which you did not know how to answer, and had to wait the next message, thus wasting time?
- How important is it to agree in advance on the messages to be transmitted, assessing all cases imaginable?
- What elements must a message contain in order to be effective?
- What kind of messages are not suitable, and why?
- In what ways can the transmission of messages, even if they are correct, fail?

With the teacher, draw a parallel between the problems seen during the game and the real situations which may occur during a space mission.

- Why planning the communication with the probes on Mars is so important?
- Why don't we have these problems on Earth?
- What differences are there between planet Mars and planet Earth?

As an alternative, questions like can asked in the form of test with multiple or open answers.

CURRICULUM

This activity can be inserted directly within the program od Science in Primary or Junior Secondary schools. This activity presents several aspects of multidisciplinarity, and can be, for instance, included in a project about space, inasmuch as it joins scientific and geographical aspects with physical activity, and can slo be a laboratory of Italian language (in its stage of planning and composition of messages).

The preparation of rovers can be proposed to pupils (technology-art).

Listed below a few topics contained in the National guidelines for the fifth year of primary school, which are covered by this activity.

- handling the class as a group, by promoting bonds among the components, and managing possible conflicts induced by socialisation.

- encouraging the development of analytical and critical thought, learning to learn, cultivate phantasy and original thought, compare among one another in order to seek meanings, and share possible patterns for understanding reality, while reflecting on the sense and consequences of one's own choices.

- ITALIAN: Mastering and applying in different situations the basic knowledge as related to the logical and syntactic organization of a simple phrase, to the parts of the speech (or lexical categories) and to the main connectors. Teachers should use a languge style appropriate to various situations.

- GEOGRAPHY: Pupils should be provided with space coordinates, so as to orientate in the territory, and get used to analyze each element in its own space context, in a multiscale fashion. The pupil is oriented in the surrounding space by using topological references and cardinal points

- MATHEMATICS: Mathematical knowledge contributes to the cultural formation of both people and communities, by developping the ability to put in close relationship «thinking» and «doing», and offering appropriate tools to perceive, interpret and connect natural phenomena, contributes to develop the capacity to communicate and discuss, argue correctky, understand people's viewpoints and claims. In primary schools, teachers can use games, which play a crucial role in communication, education to the riespect of shared rules, elaborating strategies for different contexts. It describes, denominates and classifies figures on the basis of geometric features, and determines measures.

- SCIENCES: The observation of facts and the spirit of research should characterize also an effective teaching of sciences and should take place through a direct involvement of pupils, by encouragin them to plan experiments/ explorations by following hypothesis of work and build their interpretative models. Experimental research, whether individual or by groups, strengthens in young people the trust in their own thinking, willingness to give and receive help, learning from one's won and other people's mistakes, opening up to different opinions, and being able to argue one's own ideas. Concrete experiences may be

realized either in the classroom or in other suitable spaces, such as schhol labs, but also natural spaces which can be reached easily. The pupil develops attitudes of curiosity and a new way to look at the world, which stimulate him to look for explanations of what he/she sees happening all around

- PHYSICAL EDUCATION: In the first cycle, physical education promotes knowledge of oneself and of one's own potentials in a constant relationship with the environment, people, and objects. Sports activity promotes the value of respect of agreed and shared rules, as well as the moral values which constitute the basis of life in society. There is a number experiences which allow pupils to develop game and sports skills.

ADDITIONAL INFORMATION

This activity can be readapted to a different target, for high school students. In this case the messages can be sent with an additional programming activity.

CONCLUSION

How can you drive a rover on Mars?

With this activity we wanted to underline in a playful way the problems related to the time-delay in the exploration of the Solar System, in particular in searching for water on Mars. The children have tried out the importance of a good planning and the best strategy in planning remote operations.

Self-education and self-learning among children represents the main way through this this teaching experience takes place.

CITATION

Padova; Elena Sissa; Francesca Damiani, , *Driving on Mars*, astroEDU, 2001 doi: 10.20371/inaf/astroedu/2020_0001

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