

Planning an Interplanetary Voyage

This activity was developed by science teachers and published at: Galvão et al. (2006). *Avaliação de competências em ciências: Sugestões para professores do ensino básico e do ensino secundário*. Lisboa: ASA.

The planning of a space voyage is the pretext for a reflection on environmental issues, namely the need for the management of natural resources as an indispensable condition for survival. This activity may be carried out in the subject areas of science (Physics and Chemistry; Natural Sciences) from the 3rd cycle of Basic Education (13 to 15 years old students) and from Secondary Education (Physics and Chemistry; Biology and Geology).

Skills involved

- Substantive knowledge - by using different knowledge from the area of biology, ecology and physics to define survival proposals; by explaining the importance of technology in preserving the environment and maintaining the quality of life; by understanding the importance of the balanced and responsible use of natural resources in maintaining life on Earth; by understanding the interactions that are established between science, technology and society.
- Reasoning - by collecting and analysing information; by relating knowledge from different areas of knowledge; by formulating value judgements; by being able to justify their arguments and analyse and evaluate the arguments of others; by taking decisions; by demonstrating organisation and management of work and critical thinking.
- Communication - by presenting, explaining and debating ideas; by expressing arguments in defence of his/her ideas; by being able to use the potential of the Internet in research on this subject.
- Attitudes - by cooperating with peers; showing tolerance towards peers and their different opinions; being able to discuss and defend values such as democracy, responsibility, sensitivity, thoughtfulness and respect for human beings and nature.

Learning situation

The activity starts with the problem of planning a space voyage to Mars during which the use of life-sustaining techniques is not allowed. In order to promote accountability and allow for individual assessment of the group members, each student is assigned a different role: 1) doctor in medicine; 2) scientist; 3) mission manager; 4) engineer, who will be responsible for designing and maintaining the spacecraft and the crew. Each set of students with differentiated roles will meet, giving rise to varied plans and options.

The activity involves two distinct tasks:

1. Each student collects and analyses information with the aim of writing an individual report (maximum two A4 pages) summarising their contribution to this journey. There are a number of extremely interesting web pages on the subject that students may wish to consult:
 - **NASA:** United States Space Agency <http://www.nasa.gov/>

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- **ASK-A-SCIENTIST - NASA-wide resources:** *Extremely interesting site with varied information on space travel, the universe, the solar system, effects of weightlessness...*
<http://science.msfc.nasa.gov/FAQ/ask-a-scientist.htm>
- **Exploring Mars** - <http://www.exploringmars.com>
- **Life on Mars?** - <http://www.jsc.nasa.gov/pao/flash/>
- **Mars Missions** - <http://mpfwww.jpl.nasa.gov/> <http://mars.jpe.nasa.gov/classroom/teacher.htm>

Both the research and the report of each expert may be guided -by the following questions:

Role	Some guiding questions for the research
Doctor in medicine	What health problems result from the absence of a gravitational field? How can these problems be overcome? How can the health of the crew be ensured?
Scientist	What supplies will they need? How will they obtain food for such a long journey? How will it be stored? How will the air and water needed for the crew to survive be recycled? What will be done with the rubbish and other waste? How will the crew be able to bathe? How can they eat fruit?
Mission manager	Who should be part of the crew of this ship? Who and how will play the leadership of the crew? What rules will have to be defined to ensure the success of the mission? How can funding be obtained? How can the need for the trip be justified to the public?
Engineer	What shape will the ship take, in order to optimise its movement in space? What materials will it be made of? How will it move? How will it obtain energy to operate and maintain its systems? What is its maximum possible speed?

2. The second task involves drawing up a proposal for space travel with the contributions of each of the experts. At the end, each group will present their work to the whole class, who will in turn discuss the suitability and feasibility of the plans presented.

Evaluation

In order for assessment to have a formative dimension, students should be informed in advance of the criteria that will be used in assessing their work. The assessment of this activity should focus both on the individual reports and on the construction and presentation of the plans.

The **assessment of the reports** may be carried out according to the following criteria (in brackets you will find the area of competence to be assessed):

- Knowledge demonstrated on the issues concerned; correctness of the information and concepts presented (Knowledge).
- Quality of the information collection and analysis process; plausibility of the proposals presented (Reasoning).
- Ability to use the Internet to obtain answers to the proposed questions; clarity in the presentation of the information collected and analysed (Communication).

The **assessment of the group work** (construction of the voyage plan) can focus essentially on the areas of attitudes and communication, in particular on the following aspects:

- Accountability for assigned roles/tasks; type of personal intervention; attitude towards conflicts; intervention in problem solving; time management (Attitudes).
- Oral participation (Communication).

The following rubrics can be used by you and your students at different moments of the module:

Group work					
	1	2	3	4	Points
Accountability for assigned roles/tasks (1)	Does not perform any of the roles/tasks assigned to him/her, and his/her colleagues have to do their part	Rarely carries out the roles/tasks assigned to him/her; frequently needs to be reminded of his/her duties	Usually does his/her job; rarely needs to be reminded of his/her duties	Always carries out his/her roles/tasks without needing to be reminded of his/her duties	__/ 4
Type of personal intervention (1)	Rarely comes up with useful ideas during group work. Does not follow the work progress	Collaborates punctually, although he/she is sometimes distracted from the group's tasks	Collaborates and is responsible for the tasks assigned to him/her	Collaborates in all tasks and encourages the participation of his/her colleagues. Contributes decisively to the success of the work	__/ 4
Relationship with others (1)	Demonstrates apathy or authoritarian leadership, contributing negatively to the group	Shows some interest, although he/she does not interfere with the group dynamics	Shows interest in the group dynamics, contributing to the work	Interacts with others or leads in a way that values the work of the group	__/ 4
Decision-making (1)	Does not try to solve problems or to help their colleagues solving them	Does not suggest or improve solutions, but is willing to experiment the solutions proposed by his/her colleagues	Improves the solutions presented by the colleagues	Actively seeks and proposes solutions to the problems at hand	__/ 4
Time management (1)	Does not complete the requested tasks within the deadline and the group has to postpone the delivery of the work	Tends to put off completing the tasks. The group does not have to postpone the delivery of the work but the quality of the work is affected by his/her behaviour	Tends to put off completing their tasks but manages to meet deadlines. The group does not have to postpone the delivery of the work	Manage time well and ensure your tasks are completed on time	__/ 4
Oral participation (2)	Does not interact or talks all the time and does not allow anyone else to talk	Is almost always talking and rarely allows anyone else to speak	Listens, but sometimes talks too much	Listens and speaks in a balanced way	__/ 4
Total					__/ 24

During the presentation of the work to the class, several skills can be assessed, such as knowledge, reasoning and communication:

- Scientific Correctness (Knowledge);
- Justification of the argument (Reasoning);
- Speech accuracy; articulation among the group members; clarity and objectivity of the communication; ease of presentation of the information; capacity to arouse interest; quality of the audiovisual support used; creativity evidenced; time management; voice quality (Communication).

Communication to the class

	1	2	3	4	Points
Scientific correction (1)	Presentation with several incorrect concepts or information	Presentation with some incorrect concepts or information	Presentation without any incorrect concepts or information	Presentation revealing an excellent command of concepts and information	___/ 4
Justification of the argument (2)	Group members are not sufficiently prepared to defend aspects of their work; They do not have the necessary knowledge or skills	Several members of the group have poor knowledge of the content of their work OR are unable to justify their arguments	Most of the group members show a good knowledge of the content of their work and of the justification of argumentation	All elements of the group show a deep knowledge of the content of their work and justification of argumentation	___/ 4
Speech correction (3)	Speech difficulties and grammatical inaccuracies, pronunciation and scientific language	Grammatical lapses and difficulties with pronunciation and scientific language	Reasonably well articulated speech, with no grammatical or pronunciation errors or inaccuracies in scientific language	Very well articulated speech, with no grammatical or pronunciation mistakes and correct use of scientific language	___/ 4
Articulation between the members of the group (3)	There is no articulation between the various elements of the group; Disorganised presentation	Weak articulation between the various elements of the group. It becomes evident that some of them did not prepare the presentation	Good articulation between most elements of the group. However, some elements did not prepare the presentation with the others	Excellent articulation between the various elements of the group; Logical and extremely well organised presentation	___/ 4
Clarity and objectivity (3)	Unclear and unobjective presentation, without highlighting key aspects	Clear presentation, but not very objective; Many superfluous aspects were presented	Clear presentation, but with some superfluous aspects	Clear and objective presentation, highlighting the key aspects	___/ 4
Presentation of information (3)	Information is read out rather than displayed	Most information is read rather than displayed	The information is presented but accompanied by the reading of some notes	The information is presented and not read	___/ 4
Capacity to raise interest (3)	Presentation that is bumpy and ineffective in capturing the audience's attention or interest	Presentation with some mishaps and not always effective in capturing the attention and interest of the audience	Presentation with some mishaps but effective in capturing the attention and interest of the audience	Well-rehearsed presentation, smooth and effective in capturing the audience's attention and interest	___/ 4
Audiovisual support (3)	Does not use any audiovisual element to support or enhance the content of the presentation (images, schemes/graphics, videos)	It uses some audiovisual elements of poor quality	It uses quality audiovisual elements but does not exploit them properly	Uses high quality audiovisual elements to support or enhance the content of the presentation (images, schemes/graphics, videos)	___/ 4
Creativity (3)	Uncreative presentation, both in terms of methodology and materials used	Uncreative presentation in terms of methodology and materials used	Presentation with several creative aspects at the level of methodology and materials used	Extremely creative presentation both in terms of methodology and materials used	___/ 4

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Time management (3)	It does not respect the time either by excess or by defect	The presentation considerably exceeds the time allotted to it	The presentation slightly exceeds the time allotted to it	Optimal management of available time	__ / 4
Use of voice (3)	Inaudible speech, with monotonous voice, without inflections and expressiveness	Speech with large oscillations in voice volume, but without expressiveness	Audible speech for most of the presentation, with inflection and expressiveness	Audible speech throughout the presentation, good articulation of voice with audiovisual aids	__ / 4
Total					__ / 48