New Era's Museums:

STEAM

Teaching Environments for Secondary School Education

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MINI MOOC : FLY ME TO THE MOON

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INDEX

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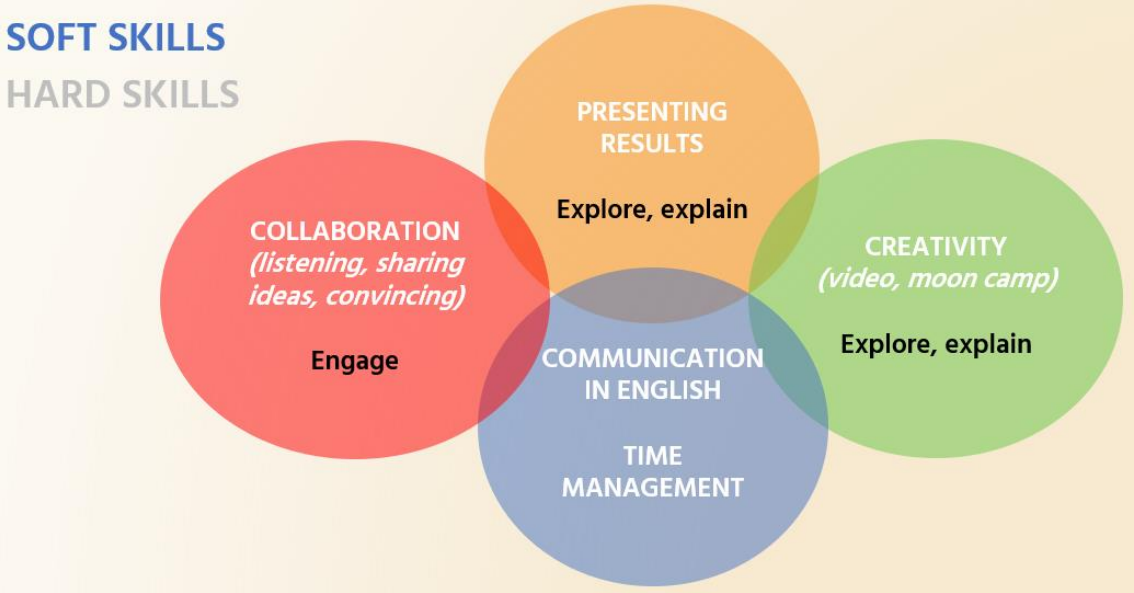
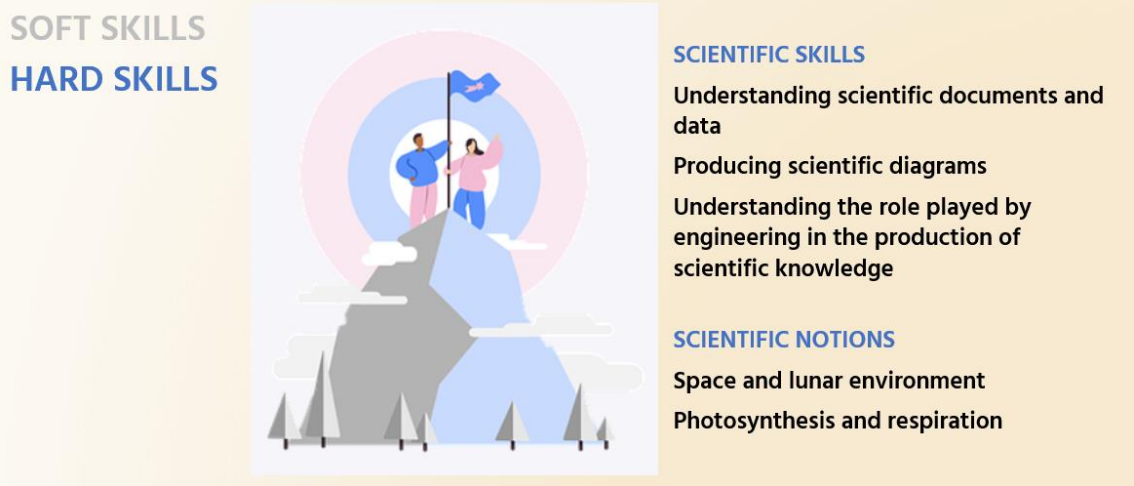
Introduction : Fly me to the moon

This sequence highlights that behind the technical feat of going to the Moon, there is a lot of engineering and technology. It also develops several skills.

Soft skills developped :



Hard skills developped :



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Storytelling of the MOOC

All the proposed activities are part of a storytelling.

The aim is to train engineers and astronauts in order to prepare the Apollo 2035 mission, intended to establish the first inhabited lunar base.

A robot intervenes at the beginning of each module to remind the storytelling.

Example of the narrator robot in introduction of the MOOC

It is also possible to replace this storytelling by a short introduction on the Apollo 11 mission.

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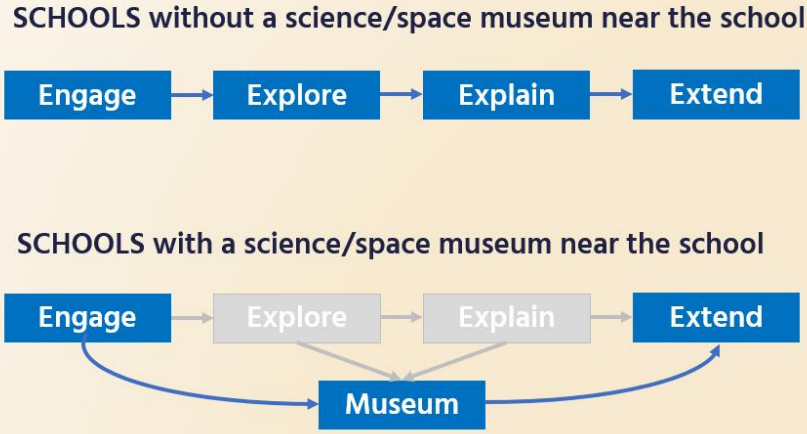
Use of the MOOC

FOR SCHOOLS : the MOOC is divided in 4 parts :

1. engage,
2. explore,
3. explain,
4. extend.

The explore and explain parts can be replaced by a visit in a space museum.



FOR MUSEUMS : the MOOC can be proposed on the museum website, especially for the scholar public. The engage part can be done before the visit and the extend part can be done after. The explore and explain part can be replaced by the museum materials.

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1. Engage : accident on the Moon (1h)

Objectives

During this phase, the objective is twofold:

- To become familiar with the theme of space travel from the Earth to the Moon
- To work on group decision making

Example of storytelling for this phase

Instructions for the task

Imagine an accident on the moon: the aim is to find the essential equipment to reach the mother rocket, by classifying 15 objects in order of importance (see Appendix 1: instruction sheet).

The exercise is done individually and then in groups. The different rankings are then compared.

Detailed sequence

Individual ranking: 10 minutes

Each participant, after having received the instruction sheet (Appendix 1), fills in a copy of the decision sheet (Appendix 2). During this phase, no exchange between the participants is allowed.

Collective ranking (30 minutes)

Participants meet to determine a collective ranking of the same elements, in subgroups of 5 to 6 people. Then they fill the column "Collective ranking".

Explanation and scored results (20 minutes)

The facilitator gives the participants the criteria on which the N.A.S.A. experts based their ranking. Participants can then calculate the individual score and the collective score by counting the difference between the chosen rank and the NASA rank for each item. Then the total sum of the differences is made. The closer the score is to 0, the better the result.

During the debrif, two aspects can be discussed :

- Group Functioning
- Comparison of individual and group rankings

For the evaluation : see appendix 4 – evaluation form 1

Comparison of individual and group rankings

In the majority of cases, the subgroup performed better than the individuals in it. This is due to the elimination of errors through the exchange of knowledge between participants and to the group's creativity in finding original ways to use certain elements.

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2. Explore : How did we get to the moon ? (1h)

Objectives

Understand that the success of the Apollo 11 mission to the Moon, and the safety of the astronauts, was based on engineering, ingenuity and technology.

Example of storytelling for the second training module

Instructions for the task

Materials available used for this activity come from the science museum of London.

Link : https://www.sciencemuseum.org.uk/objects-and-stories/technology-it-took-get-moon

Make a diagram showing the three different ways to go to the Moon imagined by the engineers. For each one, indicate what it implied at the engineering/technological level.

If you have time : make a stop motion video instead of a diagram.

DIAGRAM :

Visual way to explain something. It can be a mind map, a drawing, a graph, a ppie chart, etc.

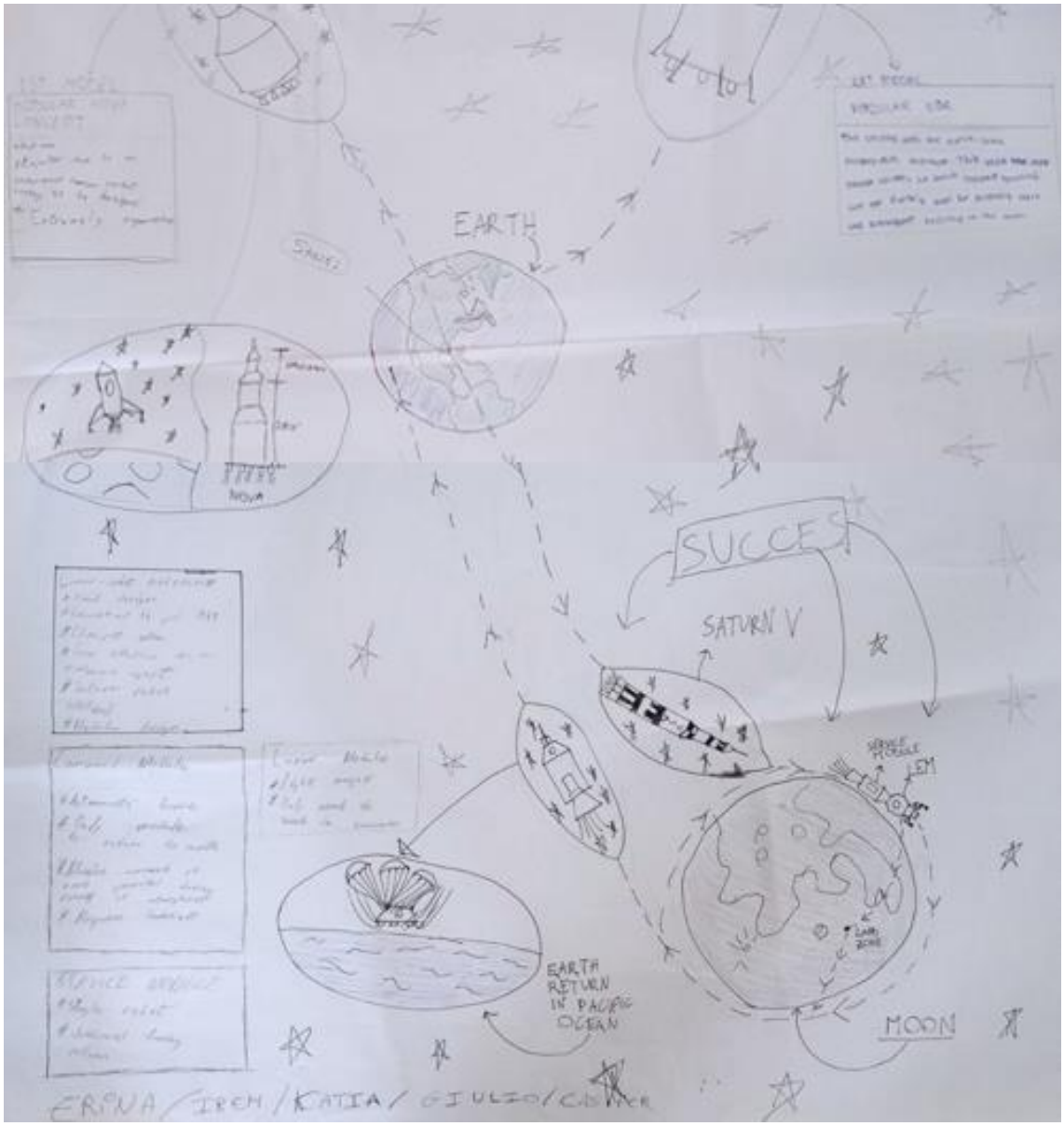
See below some examples of students productions.

To end this step, we can use an online video explaining which way ahs bee chosen to go to the Moon :

https://www.youtube.com/watch?v=-oaJmgm8hs4

For the evaluation : see appendix 4 – evaluation form 2

Example of students diagram(1/2)



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Example of students diagram(2/2)

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3. Explain : The technology it took to get to the moon (1h)

Objectives

Understand that the success of the Apollo 11 mission to the Moon, and the safety of the astronauts, was based on engineering, ingenuity and technology.

Example of storytelling for the third training module

Instructions for the task

Materials available used for this activity come from the science museum of London and the following article : The Amazing Handmade Tech That Powered Apollo 11's Moon Voyage

The classroom must be divided in 5 groups, each being assigned one of the following topics :

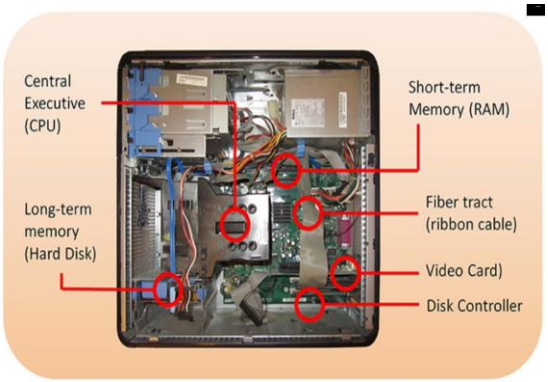
- The spacesuits
- The lunar rover
- The parachutes
- The heat shield
- The computers

Each group has then 50 minutes to propose a short video in the format of a documentary presenting the technological and engineering advances implemented during the Apollo 11 mission.

Then all the documentaries produced are viewed together.

For the evaluation : see appendix 4 – evaluation form 3

Example of students productions (screenprint of the video)



4. Extend (1h – Xh)

Participate to the moon camp challenge : https://mooncampchallenge.org

Objectives

Explore the extreme environment of space and understand how astronauts could live on the Moon. In this activity, it is posible to propose to include two kind of lunar modules :

- plant module : plants produce O_2 – thanks to photosynthesis – that can be used for the human and other animal respiration in the moon camp;
- animal module : animals can eat plants and be eaten by settlers in the colony. Furthermore, they produce CO_2 – like human being – that can be used by plants for their photosynthesis.

Example of storytelling for the last training module

Instructions for the task

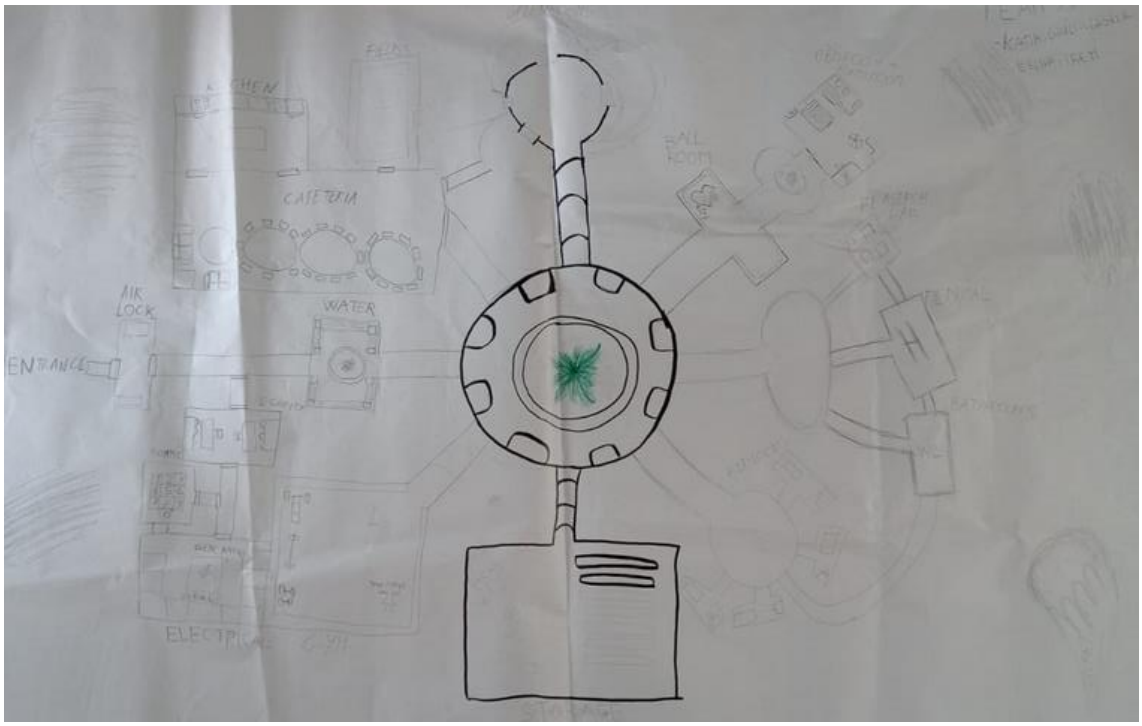
Depending on the time allocated to this phase, it is possible to just wonder about the extreme conditions of the space environment and the constraints that this imposes on lunar colonists.

With more time, it is possible to get involved and participate in the challenge which consists in designating a lunar base in 3D.

During this activity, the scientific notions below can be discussed :

- extreme environment of life on the Moon :
  - lack of liquid water → linked to the composition of living beings, linked to photosynthesis
  - no oxygen in the atmosphere → linked to respiration and to the production of ozon (O_3), linked to photosynthesis
  - high solar radiation → linked to mutation of DNA caused by UV
  - no food
- reactions of the metabolism :
  - respiration
  - photosynthesis

Example of students productions (1/3)



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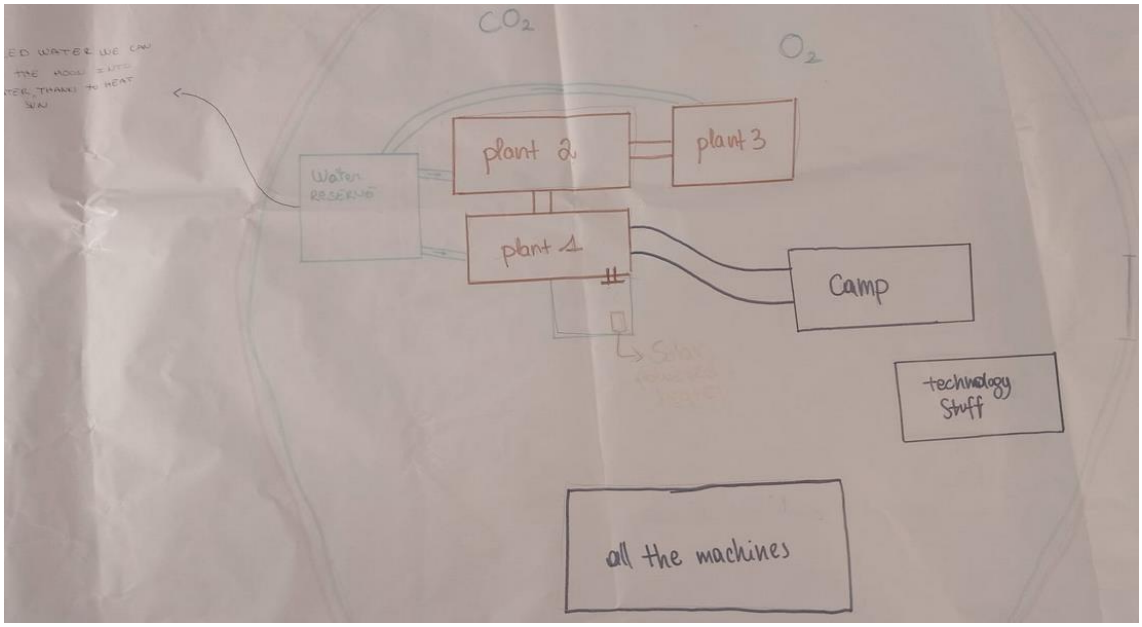
Example of students productions (2/3)



Example of students productions (3/3)

5. Evaluate

Several parts are subject to student analysis, reflection, and self-evaluation :

- engage phase : functioning of a group to make collective decisions
- explore phase : cross-assessment of the diagrams proposed by peers
- explain phase : cross-assessment of the videos proposed by peers
- Explore phase : assessment about the scientific notions

For the proposals of evaluation forms, see Appendix 4

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APPENDIX 1 : instructions for the engage phase

INSTRUCTIONS

(To be given to each participant)

You are part of the crew of a spacecraft originally programmed to reach a mother rocket from the illuminated side of the moon. Due to mechanical problems, you had to land about 320 km from the scheduled rendezvous. During the landing, most of the on-board equipment was damaged, except for the 15 objects below. It is vital for your crew to get back to the mother rocket and you must choose the essential equipment for this long trip.

The exercise consists in classifying the 15 items in order of necessity. Put the number 1 in front of the one you think is most important, 2 in front of the next one, and so on until you reach 15 in front of the one you think is least useful (Appendix 2 - decision sheet).

A matchbox

Concentrated food

50 meters of nylon rope

A silk parachute

A solar powered heater

2 x 45 caliber pistols

A case of powdered milk

2 tanks of 50 kg of oxygen each

A celestial map of the lunar constellations

A self-inflating lifeboat

A magnetic compass

25 liters of water

A medical kit and hypodermic syringes

Light signals

A solar powered transceiver (medium frequency)

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APPENDIX 2 : decision sheet for the engage phase

DECISION SHEET

(To be given to each participant)

Objects	individual ranking	difference in points	collective ranking	difference in points	ranking of N.A.S.A.
A matchbox					
Concentrated food					
50 meters of nylon rope					
A silk parachute					
A solar powered heater					
2 x 45 caliber pistols					
A case of powdered milk					
2 tanks of 50 kg of oxygen each					
A celestial map of the lunar constellations					
A self-inflating lifeboat					
A magnetic compass					
25 liters of water					
A medical kit and hypodermic syringes					
Light signals					
A solar powered transceiver (medium frequency)					
	Total :		Total :		

APPENDIX 3 : results and explanations of N.A.S.A. for the engage phase

RESULTS AND EXPLANATIONS PROVIDED BY N.A.S.A

(To be given to each participant)

To establish their classification, the experts of the N.A.SA. were based on the alternate use of 2 criteria:

- what ensures biological life
- what ensures the possibility of joining the mother rocket.

These 2 criteria mean, by their association, the survival.

Objects	Explanation	ranking of N.A.S.A.
A matchbox	The absence of oxygen does not allow them to ignite	15
Concentrated food	Efficient way to repair energy loss	4
50 meters of nylon rope	Useful for roping up, climbing rocks; possibly for hoisting the injured	6
A silk parachute	Can be used to protect from sunlight	8
A solar powered heater	Not useful: suits are heated	13
2 x 45 caliber pistols	Can be used to accelerate propulsion; in a pinch to end one's life	11
A case of powdered milk	Nutritional trap: more cumbersome than concentrated food	12
2 tanks of 50 kg of oxygen each	First essential element of survival	1
A celestial map of the lunar constellations	Essential for orientation	3
A self-inflating lifeboat	Can be used as a sled to pull objects; the gas (CO) used for this device can be used for propulsion	9

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A magnetic compass	No use on the moon; the magnetic field is not valued there	14
25 liters of water	Indispensable to compensate a strong dehydration due to the very great heat on the illuminated side of the moon	2
A medical kit and hypodermic syringes	The injections of vitamins, serum etc...require a special opening (provided by the N.A.S.A.)	7
Light signals	Useful when the mother rocket is in sight	10
A solar powered transceiver (medium frequency)	Useful to try to communicate with the mother rocket but this device does not have much range	5
	Total :	

APPENDIX 4 : evaluation forms

These forms are suggestions. Participants and organising teams may chose not to use all the evaluation forms.

Evaluation form 1 – Engage : accident on the Moon

Non formal evaluations, 2 kinds of evaluation during the session :

- participants calculate their own score and compare it to the collective score : individual evaluation, no mark.
- during the debrief : discussion about the results/comparison ; analysis of the group dynamics.
- Individual and anonymous feedback form to fill in at the end of the sessions and to give to the organising team – *the form can also be performed online*

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	**Mini-Mooc : Fly me to the Moon – Feedback form – Module 1**
Session n° xxx - Date	
Instructions : answer to the following questions with key-words and short phrases, in an anonymous way.	
Did the subgroup and facilitator have a plan? (e.g., vital, useful, useless, etc.).	☐ yes ☐ no
Did each participant have the opportunity to express him or herself?	☐ yes ☐ no
Did each participant listen to the suggestions of others or did they try to impose their own list?	
Was there leadership, conflict, or grouping within the subgroups?	
How long did the various decisions take?	
Did any of the subgroups adopt decision-making methods such as majority rule, give-and-take, or chance? Were they creative?	
Any suggestion ?	

Evaluation form 2 – Explore : how did we get to the Moon ?

Formal evaluation : the participants need to produce their diagram or stop motion video in a limited period. The diagrams/stop motion videos are evaluated in order for the teachers to get a feeback on their comprehension level of the topic, of the exercise and of the skills. *Depending on the country's/teaching teams'habits related to evaluations, the participants can get a mark or a simple feedback on their work, with some advices. In this form, we use a French classical way to evaluate highschool students, with a mark on 10 pts (10 is the best score, 0 the poorest) and a space where the teachers can adress some advices.*

<table>
<tr><td colspan="4">  Mini-Mooc : Fly me to the Moon – Evaluation form – Module 2</td></tr>
<tr><td colspan="2">Part 1 – Production</td><td colspan="2">Part 2 – Oral presentation</td></tr>
<tr><td colspan="4">Level 1</td></tr>
<tr><td>Instructions have been partially followed : the diagram/video is incomplete ; museum's materials have been partially used ; the diagram/video is basic work</td><td>0-2 pts</td><td>The oral presentation can be improved : the vocabulary is basic ; there are some spelling, syntax and grammar mistakes ; the pronunciation can be improved</td><td>0-2 pts</td></tr>
<tr><td colspan="4">Level 2</td></tr>
<tr><td>Instructions have been correctly followed : some details are missing, but the essential informations have been presented ; the museum's materials have been correctly used and presented ; the diagram/video has been well shaped</td><td>3-5 pts</td><td>The oral presentation is satisfying : there are some mistakes, but the vocabulary is relevant ; the presentation is easy to understand ; the pronunciation is fluent</td><td>3-5 pts</td></tr>
<tr><td colspan="4">Global score on 10 pts :
Comments :</td></tr>
</table>

Evaluation form 3 – Explain : the technology it took to get to the moon

- **Formal evaluation** : the participants need to produce their video in a limited period. The videos are evaluated in order for the teachers to get a feeback on their comprehension level of the topic, of the exercise and of the skills. *Depending on the country's/teaching teams'habits related to evaluations, the participants can get a mark or a simple feedback on their work, with some advices. In this form, we use a French classical way to evaluate highschool students, with a mark on 10 pts (10 is the best score, 0 the poorest) and a space where the teachers can adress some advices.*

Mini-Mooc : Fly me to the Moon – Evaluation form – Module 3

Part 1 – Production		**Part 2 – Oral presentation**	
Level 1			
Instructions have been partially followed : the diagram/video is incomplete ; museum's materials have been partially used ; the diagram/video is basic work	0-2 pts	The oral presentation can be improved : the vocabulary is basic ; there are some spelling, syntax and grammar mistakes ; the pronunciation can be improved	0-2 pts
Level 2			
Instructions have been correctly followed : some details are missing, but the essential informations have been presented ; the museum's materials have been correctly used and presented ; the diagram/video has been well shaped	3-5 pts	The oral presentation is satisfying : there are some mistakes, but the vocabulary is relevant ; the presentation is easy to understand ; the pronunciation is fluent	3-5 pts
Global score on 10 pts : Comments :			

- **Peer to peer evaluation** : during the documentaries' presentation, the other participants fill in a feedback form for each documentary, which can be used to check the understanding level of all the participants and as a tool for the discussion following the documentaries' presentation. The forms are not anonymous, in order to launch the discussion after the viewing. *The feedback form can also be completed online* :

 **Mini-Mooc : Fly me to the Moon – Feedback form – module 3**	
Session n° xxx – Date	NAME :
Instructions : answer to the following questions with key-words and short phrases.	
Did you easily understand the video ?	☐ yes ☐ no
What were the technological and engineering advances presented in the video ?	
Did all the participants stick to the instructions to make their video ?	☐ yes ☐ no
Any suggestion about the documentary ?	

Evaluation form 4 – Extend

Formal evaluation : the participants can be evaluated on the scientific notions discussed during the extend phase. The good answers are in bold red.

QUIZ ABOUT THE SCIENTIFIC NOTIONS

1. **What are the gazes exchanged during photosynthesis ?**

□ Oxygen is absorbed and carbon dioxide is released

□ **Oxygen is released and carbon dioxide is absorbed**

□ Both oxygen and carbon dioxide are absorbed

□ Both oxygen and carbon dioxide are released

2. **Which kind of living beings can process the photosynthesis ?**

□ All kind of living beings

□ Plants and animals

□ **Mainly plants**

□ Mainly animals

3. **What are the gazes exchanged during cellular respiration ?**

□ **Oxygen is absorbed and carbon dioxide is released**

□ Oxygen is released and carbon dioxide is absorbed

□ Both oxygen and carbon dioxide are absorbed

□ Both oxygen and carbon dioxide are released

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4. What can solar radiation cause to living beings ?

□ Boiling of the body water

□ **Genetic mutations**

□ Death by burns

□ Lack of oxygen

5. What are the elements that protect living beings on earth from solar radiations ?

□ Oxygen in the atmosphere and the biosphere of the planet

□ **Ozone in the atmosphere and the magnetosphere of the planet**

□ Carbon dioxide in the atmosphere and the hydrosphere of the planet

□ Water vapor in the atmosphere and the lithosphere of the planet

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